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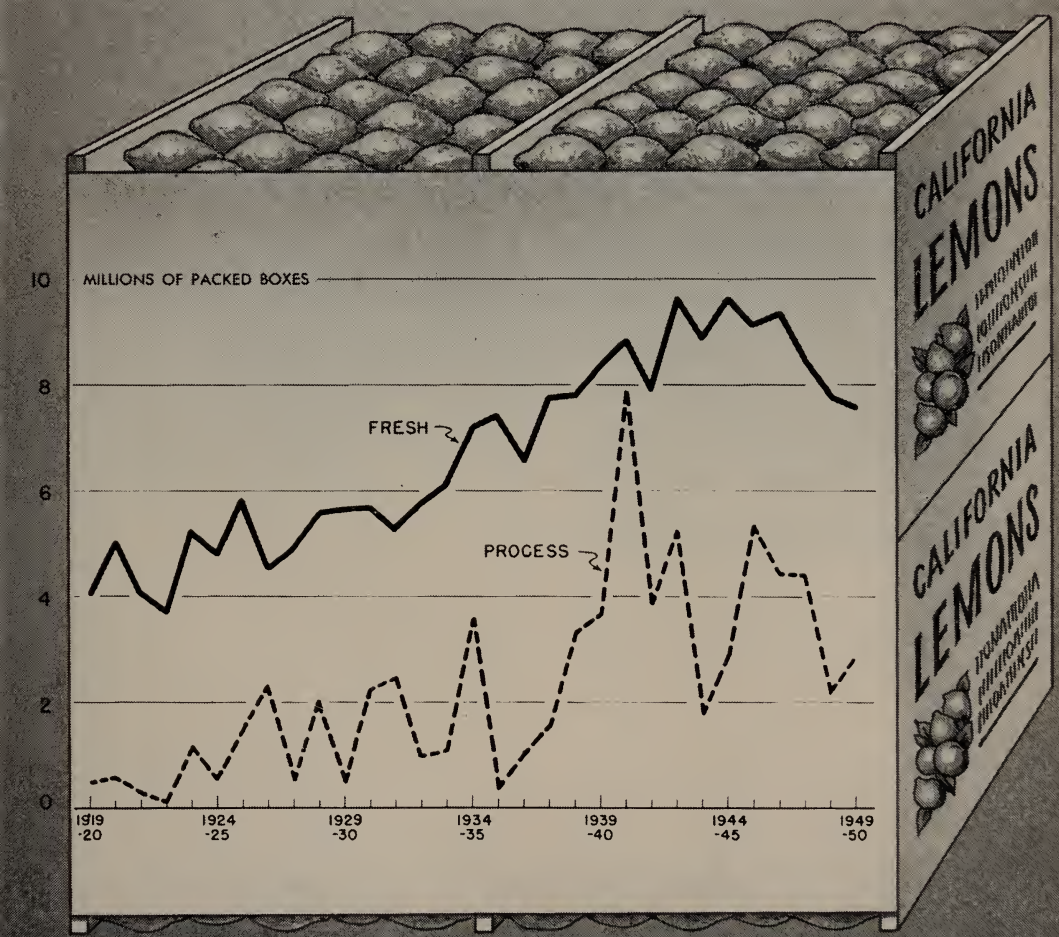
LEMONS
AND LEMON PRODUCTS
CHANGING ECONOMIC RELATIONSHIPS, 1951-52

SIDNEY HOOS and R. E. SELTZER



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A number of basic economic questions face the lemon industry today: In the marketing of the lemon crop, what proportion should be shipped fresh and what proportion processed? How competitive are the juice products to fresh lemons? How has production been affected by changing yield and acreage? How will the 50% cut in tariff on lemon imports affect markets for both fresh and processed fruit?

This bulletin discusses the above and related problems in today's changing marketing scene. Its purpose is to provide information helpful in adjusting to conditions so the fresh and products markets may be developed and expanded.

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LEMONS AND LEMON PRODUCTS:

Changing Economic Relationships,* 1951–52

SIDNEY HOOS and R. E. SELTZER

INTRODUCTION

LEMONS, one of the major citrus crops, are an important agricultural commodity in California. The lemon industry in the state includes the cultivation and management of groves for the production of the fruit; picking, packing for fresh shipment and movement to processing; and the operation of processing plants for the production and shipment of processed lemon products. Such production and sales activities provide for the employment and income of thousands of people. In addition, there is a wide range of subsidiary or secondary industries which depend in considerable part on the lemon industry. Such secondary industries include lumbering and box factories, rail and truck transportation firms, fuel and gasoline suppliers, insecticide manufacturers, and farm machinery and equipment companies. Hence, the economic status of the lemon industry itself directly affects other segments of the state's economy.

Developments during the past several years have raised new questions and brought into greater prominence existing production and marketing problems. The lemon industry appears to be experiencing a transition period during which the marketing structure is undergoing modification. This change has repercussions on market prices, returns to shippers and growers, and the utilization of the crop. Long-established marketing practices are being modified in the light of current and prospective developments. For these reasons a review of the economic status of the lemon industry and a consideration of its marketing problems are appropriate at this time.

In order to provide adequate background, the first major section of this report presents a review of some of the important economic developments in the lemon industry. Attention is given to trends and changes in acreage, yields, production, and picking and storage; also discussed are utilization, domestic shipments, imports, and prices. Rather than providing a detailed description of such developments, the major and significant aspects are highlighted, so that the marketing and crop-allocation problems later considered have their proper setting. Those who are familiar with the economic trends in the lemon industry may benefit from the first section primarily in that it provides a pertinent background for the later sections. Those who have only a limited familiarity with the trends in the industry may need acquaintance with the first section of the report so as to have appropriate perspective for the consideration of the production-marketing problems involved and discussed in the later sections.

The second major section of the report is concerned with presenting and clarifying the essential characteristics of the demand for lemons. Particular attention is given to the domestic demand for lemons shipped for fresh use. The nature of lemon demand is of significance to the formulation of marketing policies and programs because of its interconnection

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with relative changes in prices and associated relative changes in sales, and thereby its reflection of the behavior of money returns from sales. Attention is also given, to the extent that available statistical data permit, to the demand relations between fresh lemons and canned lemon juice. The demand characteristics of fresh lemons and their relation to processed lemon products are now highly pertinent to marketing decisions, especially in view of recent developments in the markets for certain processed lemon products such as canned juice and frozen lemonade concentrate.

The third major section of the report—the one to which the earlier sections serve as a necessary introduction—is concerned with the impacts on the lemon industry resulting from developments in the processed lemon products markets. This first entails identification of how the lemon crop has been utilized in the past, and what trends are developing in the allocation of the crop among alternative uses. Then attention is directed to the effects on prices and returns resulting from the manner in which the lemon crop is distributed among the major usages. This concerns alternative marketing policies which may have differential effects with respect to grower equities.

SUMMARY AND CONCLUSIONS

Lemons are a major crop in California. In recent years, grower income from lemons in the state averaged some 40–45 million dollars annually. In the seven counties where the bulk of the state's lemon acreage is located, the lemon crop accounts for 10 per cent of the agricultural income; in Ventura County, about 40 per cent of the total agricultural income comes from lemons.

The present status of the state's lemon industry reflects some significant changes. There was little increase in lemon-bearing acreage during 1920–1936. During the late 1920's, however, considerable new acreage was planted, and beginning in the middle 1930's there developed a gradual expansion in bearing acreage which reached a peak in 1946–47. New plantings since then have been small, and bearing acreage has decreased.

Lemon yield per bearing acre followed an upward trend from 1919–20 through 1935–36, then increased at an accelerated rate until an all-time peak was reached in 1940–41. Since then the yield has tended to decrease and in recent years has fluctuated around the level which prevailed in the latter 1930's. The increasing yield up to the end of the 1930's was due in large part to the increasing age of the existing acreage, with a larger proportion of trees coming into full bearing. Improved management and cultural practices, however, as well as plantings on more productive soils, also contributed to the greater yield.

During the past ten years, a shift has occurred in the age structure of lemon trees. In contrast with a decade earlier, there are now fewer very young trees—about three times as many trees which are near to full-bearing, and slightly fewer mature and older trees. The change in age structure occurred along with a decline in total acreage, and with bearing acreage remaining about the same. Hence, the decline in total acreage has resulted primarily from a decline in nonbearing acreage. This change in age distribution may have no noticeable effect on average yields in the next few years. But with fewer very young trees, reflecting the reduced plantings in recent years, a situation could develop wherein sufficient young stock would not come into bearing to offset removals.

The production of lemons in California generally increased from the beginning of commercial lemon production in about 1875, until 1940. Production has tended to decrease since 1940, due in part to de-

clining yields since then and in part to decreased bearing acreage since 1946–47. A combination of increased yield and expanded bearing acreage is required for lemon production to regain its earlier higher level.

Lemons are harvested throughout the year, although there is a seasonal pattern in picking activity. Furthermore, the timing of intense harvesting varies among the major producing districts. Half of the California lemon crop is harvested during the three-month period March–May, but the timing of heaviest shipment for fresh use and consumption occurs in the three-month period May–July. This calls for the storage of a substantial volume of lemons. The amount of lemons held in storage is influenced by market prices. When summer lemon prices are high relative to those of the previous winter, November 1 storage is relatively small, and vice versa. There is a noticeable negative relationship between the winter-summer lemon price ratio and volume in storage. There is also a general tendency for storage to be higher in years of extremely high production and lower in years of extremely low production. But it apparently is only the extremes in production which influence the level of supplies in storage.

Costs of production and harvesting have exhibited marked changes during the past 25 years. Estimated average costs, following the general price level, have in large part reflected the cyclical swings in the economy. Per acre costs for production and harvesting were relatively high during 1923–1930, then generally declined through the 1930's, and reached a low in 1941. With the pressure of World War II, costs began to rise and have increased rapidly since 1944. Inflationary influences during the postwar years have pushed up production costs for lemons as well as for other products. The most substantial increases in lemon production-harvesting costs in recent years have been imputed to labor; but other items such as pest control, frost protection, taxes, and insurance have also increased markedly.

Through the years, the larger part of the lemon crop has been harvested and shipped for fresh use. The lemon processing industry has operated primarily as a by-product operation, using that volume of fruit which could not be sold profitably in the fresh markets. In recent years new developments, such as frozen and canned lemon concentrates, appear to be bringing about a change in the relative importance of the market for processed lemon products. The increasing size of the lemon processing industry has not so much been the result of an increase in the total volume of lemons processed as it has resulted from an increase in the dollar value of the processed products. The change reflects a shift toward increased production of the more valuable lemon products—such as the frozen concentrates—and a decreased relative production of low-value products like citric acid.

The volume of fresh shipments of California lemons increased steadily from the earliest days of the industry until 1942–43. That level was maintained during the war years, but has generally shown a downward trend in the postwar period. Within the year, there is a pronounced and regular seasonal pattern in the volume of fresh shipments for the state as a whole. But different seasonal patterns exist for the various producing districts, with considerable overlapping. Hence, interdistrict competition prevails in the packing house sales of fresh lemons.

Through the years about 95 per cent of total fresh lemon shipments moved to domestic markets, some 5 per cent being exported. Of the lemons exported, about 70 per cent went to Canada, and during the middle 1940's that country's proportion averaged over 95 per cent. But since 1942–43, Canada's percentage has tended to decrease, and in 1949–50 amounted to about half of the total exports.

In contrast to other citrus, imports of foreign lemons are an important factor

influencing the domestic markets. During the period 1930 to 1950, the tariff on lemon imports, together with developments in the foreign producing areas, effectively limited the quantity of lemons imported into this country. In 1950, the tariff on lemons for fresh use was cut in half. At the same time, conditions in foreign lemon-producing areas were such as would permit them to increase substantially the volume of lemons available for export.

Recently a relatively marked upsurge occurred in fresh lemon and lemon products imports. This development resulted from the reduced tariff, the demand for dollar exchange in Italy, and the relatively high market prices in eastern markets. Imports reached a level which was of concern to domestic producers and shippers. With domestic lemon production such that about one-third of the crop was channeled to products outlets, growers and shippers realized that the prevailing level of fresh and processed lemon imports would result in further allocations to products outlets, including the low value uses.

The domestic demand for fresh lemons, it has been found, tends to be such that within the usual range of marketings, increased shipments yield lower f.o.b. gross revenues than do smaller shipments. This is generally characteristic of both summer and winter lemons, but somewhat more so for the winter lemons. The demands for both summer and winter lemons are responsive to changes in consumer purchasing power as reflected by the level of national income. As income increases, the demand increases; as income falls, the demand decreases. But the demand response to income appears to be more pronounced for summer lemons than for winter lemons.

The demands for both summer and winter lemons are responsive to changes in average daily temperatures in the principal marketing centers of the United States, but in different ways. As the temperature advances, the demand for summer lemons also advances; as the summer temperature declines, the demand for summer lemons recedes. In the winter lemon market, when the temperature advances, the demand declines; when the temperature falls, the demand increases.

The market for fresh lemons is to some extent affected by the price and availability of certain processed lemon products, especially canned lemon juices, and probably, frozen lemonade concentrate. Available evidence suggests the existence of some competitive demand interrelation between fresh lemons and canned lemon juice. Adequate data are not yet available to test the demand relations between fresh lemons and frozen lemonade concentrate; yet, market information generally reflects the opinion that the two products do evidence some competitive demand relation. The competitive demand relation between fresh lemons and various processed lemon products emphasizes the problem of utilizing most advantageously the lemon crop, not to introduce unbalance in the industry markets, but to promote market expansion and increased returns to the industry. This question has become of increased significance fairly recently, since canned lemon juice and frozen lemonade concentrate have reached important market development.

The question of distributing the lemon crop, in a given year, among the fresh and processed outlets involves some difficult planning and marketing problems. Yet, the consideration of such problems is of great significance to the industry. Its returns are affected, in both the short and long view. The problems concern the distribution of the lemon crop not only among the total fresh and total processed outlets, but also among the winter and summer fresh markets, as well as the various processed lemon products.

When the total annual fresh shipments which have actually occurred—winter plus summer—are considered, the evidence indicates that a satisfactory distri-

bution among the winter and summer seasons has been accomplished. The summer and winter fresh shipments, respectively, as a proportion of the annual total fresh shipments, did not vary widely from the proportions necessary to yield maximum gross f.o.b. money returns. In most years, the discrepancy did not exceed 5 per cent. The indications are that the marketing organizations shipping fresh lemons have, in the aggregate, distributed reasonably well the annual fresh supply between the summer and winter seasons. Within the practically permissible range of distribution, the seasonal allocation between the winter and summer fresh markets may be judged to have been accomplished well.

When the distribution between the total fresh and the total processed outlets is considered, the situation is somewhat different. From the view of allocating the crop among the fresh and processed outlets so as to maximize the on-tree value of the entire crop, the evidence suggests the following: there apparently has prevailed a tendency to overallocate supplies to the fresh outlet and underallocate supplies to the processed outlet. This, however, has not been so pronounced in the postwar years as during the prewar years. Yet even now, there appears to be further opportunity to augment total industry returns, at the on-tree level, by allocating some additional supplies to the processed outlet. Industry consideration might be given to a gradual adjustment along those lines, with attention given to the potential effects of imports of lemons and lemon products.

Consideration of adjusting the allocation of the lemon crop among the fresh and processed outlets, however, involves several related problems. Attainment of increased total industry returns is an important objective, but consideration must also be given to grower equity problems arising from relations among producing districts, and the allocation of the crop from the various districts to the alternative outlets. Consideration must also be given to the maintenance of satisfactory stability in the industry, and to the efficient use of fresh marketing and processing facilities. Nevertheless, adjustments may be necessary to take advantage of changing market conditions so that the markets for both fresh lemons and processed lemon products may be developed and expanded.

I. REVIEW OF ECONOMIC TRENDS IN THE LEMON INDUSTRY

The production of lemons in the United States is concentrated in seven southern California counties. California produces approximately 97 per cent of the nation's total lemon crop, and about 97 per cent of the California bearing acreage is located in these seven counties: Los Angeles, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, and Ventura.

Lemons are a major crop in California, important to the agricultural economy of the state. During the five years 1944–45 through 1948–49, grower income from lemons in California averaged over 42 million dollars annually. In the seven counties where the bulk of the state's lemon acreage is located, the crop accounted for about 10 per cent of the agricultural income of these counties during 1949. This compares with about 14 per cent of the total agricultural income of these counties received from the orange crop during that year. Almost 40 per cent of the total agricultural income of Ventura County came from lemons in 1949, the lemon crop for this county bringing in over 25 million dollars to growers in that year.

During the past several years, the value of the products of the citrus industry in California has declined in importance relative to the value of the rest of its agri-

cultural products. Prior to World War II, lemons and oranges together accounted for 15 to 18 per cent of the state's agricultural income. Since the war, the value of these two citrus fruits has amounted to about 6 per cent of the total state agricultural income. The decline, in percentage terms, from the prewar to the postwar years, occurred because lemon production decreased and citrus prices in the postwar years did not increase as rapidly as prices of most other agricultural products.

The trend in the production of lemons is determined by the trends of bearing acreage and yield per bearing acre. Although bearing acreage and yield are not wholly independent, they are affected in large part by different sets of influences. Bearing acreage is influenced by plantings and removals of trees. Yield is influenced by factors such as management and cultural practices, rootstock, age of the trees, soil, water, and climatic conditions. Hence, before reviewing production trends, it is helpful first to consider the trends in acreage and yield.

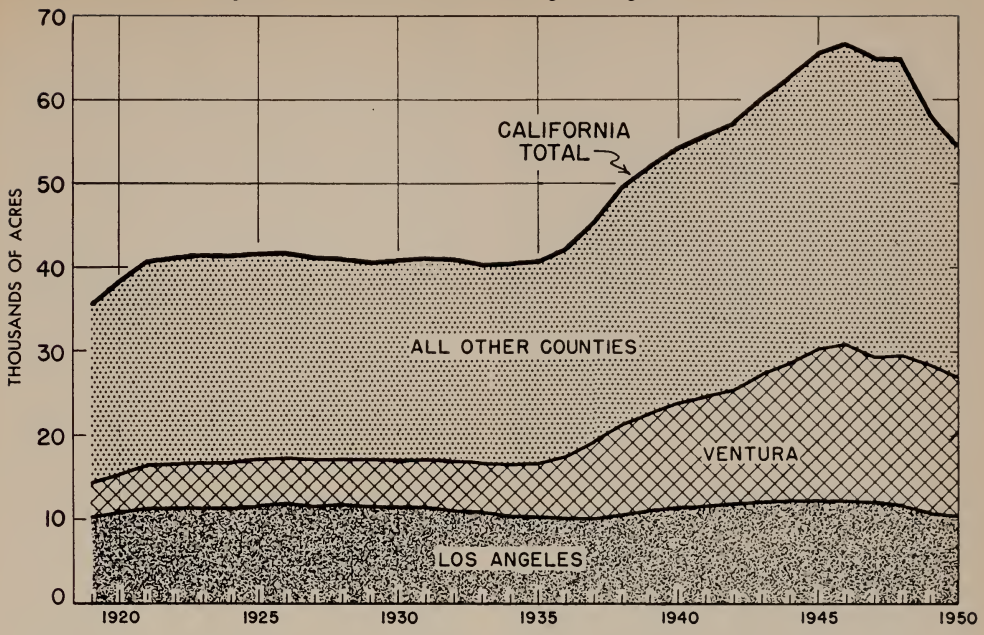
Acreage. Lemons were first brought to California from Mexico at about the same time as the orange (1769), but it was not until about 1875 that the lemon industry began to assume commercial importance. The growth of the California lemon industry paralleled that of the orange industry. As improved marketing and transportation facilities came into existence, midwestern and eastern markets were made more readily accessible, and acreage and production expanded rapidly. By 1920 there were approximately 40,000 acres of California lemons in production.

The general business depression following World War I coincided with a record lemon crop, and the expansion in production from the increased acreage had the effect of halting further plantings during the next few years. There was little increase in bearing lemon acreage during the period 1920–36, bearing acreage in 1935–36 being the same as in 1920 (see fig. 1, page 9). However, during the prosperous years of the late 1920's, substantial new acreage had been planted, and beginning in 1936–37 there began a gradual expansion in bearing acreage which reached a peak of 66,600 acres in 1946–47. New plantings since then have been smaller than during the 1930's, and bearing acreage has decreased somewhat to a total of 54,418 acres in the 1950 bloom year.

The relative importance of the major lemon-producing counties in California is changing. This change, which began in the early 1930's, has resulted in a gradual shift in the distribution of the state's lemon acreage. Figure 2, page 9, shows the percentage of the total California bearing lemon acreage found in each of the major producing counties for the years beginning with 1919. From figure 2 it is evident that bearing lemon acreage in Ventura and Santa Barbara counties has expanded much more rapidly than elsewhere in the state, with the consequence that these two counties have gained in their relative importance as lemon-producing areas. San Diego and San Bernardino counties have almost maintained their former positions, and are only slightly less relatively important than they were 20 years ago. The other producing counties have all become relatively less important than they were previously.

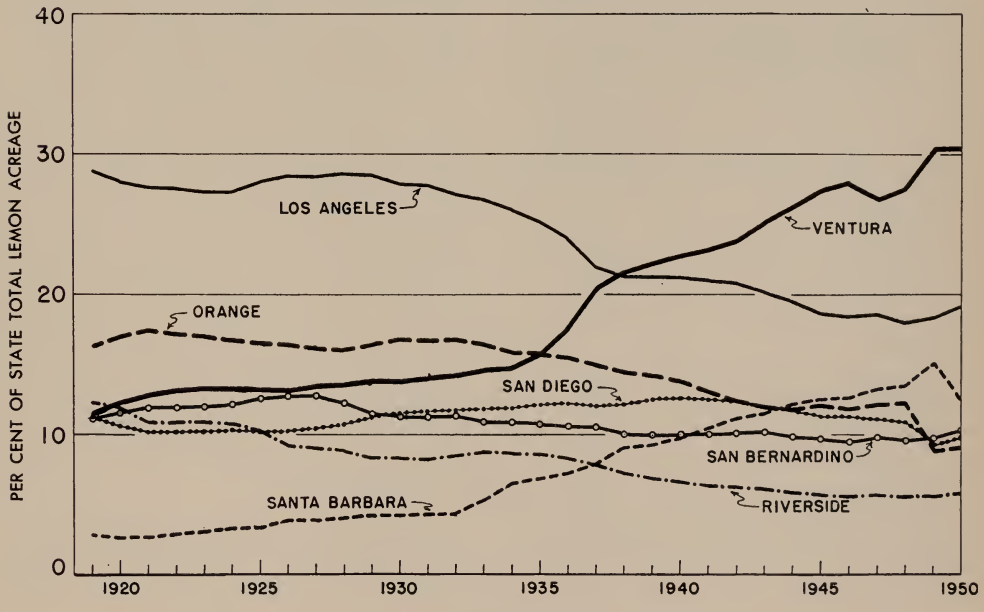
The portion of the total available agricultural land that is planted to lemons constitutes another measure of the relative importance of lemons to the agriculture of each county. Ventura County is, by far, the most highly specialized lemon-producing area, having 34 of each 1,000 acres of agricultural land planted to lemons. Los Angeles County is next with 15.8 acres per 1,000 in lemons. It is followed by Orange County, with 14.9; San Bernardino, 13.6; Santa Barbara, 9.8; San Diego, 6.0; and Riverside, 4.5 acres for each 1,000 acres of agricultural land.

Figure 1. California Lemon-Bearing Acreage, from 1919.



The Eureka is by far the most common variety of lemon produced in California. The 1944 acreage survey showed 88 per cent of the state's total lemons to be of this variety or its derivatives. The second variety of importance is the Lisbon, accounting for about 8 per cent of the total acreage. The Villa Franca variety amounts to about 2 per cent and a number of minor varieties 2 per cent more. Thus, two varieties account for the large part of the production. Those two varie-

Figure 2. California Lemon-Bearing Acreage, Percentage Distribution Among Major Counties, from 1919.



ties—Eureka and Lisbon, and especially the former—have proved to be the most acceptable for the production of lemons for fresh shipment.

Yields. Yields of lemons in California average about 200 packed boxes per bearing acre. In reviewing yields over the period since 1919–20, it appears that the average production per bearing acre followed an upward trend through 1935–36, and then increased at an accelerated rate for several years, reaching an all-time peak of 318 boxes per acre in 1940–41. Since then, the yield has tended to decrease and in recent years has fluctuated around the level of the latter 1930's. The general trend in yield is summarized in the table below. The increasing yield noted during the first half of the period was due in large part to the increasing age of the existing acreage, with a larger proportion of the trees coming into full production. Improved management and cultural practices, however, also contributed, as did above-average rainfall.

Within the state of California, there exists a rather wide range in yields among the various producing areas. The table at top of page 11 shows the average yield of lemons for the past 10 years in each of the major lemon-producing counties.

Yields, California Lemons

Period	Yield per bearing acre
	packed boxes
5-year averages	
1924–29	152
1930–34	173
1935–39	209
1940–44*	238
Annual	
1945–46	221
1946–47	207
1947–48	198
1948–49	153
1949–50	198

* 1940-41 omitted because of unusually high yields (318).

The variation in yield among the lemon-producing counties appears to have been an important factor in influencing the shift in the relative importance of each of the counties involved. Those two counties having the highest yields (Ventura and Santa Barbara) have made the greatest gain, both in actual acreage and in relative importance, and those counties having the lowest yields (San Diego and Orange) have had the greatest reduction, both in actual acreage and in relative importance. Relative yield, then, may serve as an index of relative profitability and its influence on plantings, removals and maintenance of acreage.

Since the age distribution of lemon acreage affects the average yield, it is pertinent here to consider the age status of the acreage. An indication of what has occurred in lemon acreage age distribution may be obtained by referring to the situation in 1950 as compared with 1940. The table at bottom of page 11 shows the state's lemon acreage, in both of those years, classified into five age groups. Review shows that in 1950, in contrast with a decade earlier, there were fewer very young trees, slightly fewer trees of 22 years of age or older, but three times as many trees in the 12 to 21 age group.

The indications are that in the past several years some 10–12 per cent of the acreage was nonbearing, contrasted with 20 per cent nonbearing in 1940. Somewhat less than 40 per cent of the trees were 22 years and older in both 1940 and 1950. But an important difference exists: In 1940, about 12 per cent of the trees were in the 12–21 age group and almost 25 per cent in the 7–11 age group. In 1950, however, almost 40 per cent were in the 12–21 age group, whereas only slightly more than 10 per cent were in the 7–11 age group.

The apparent shift to definitely fewer young trees and a decrease in the number of old trees has some influence on yield,

Average Yields and Changes in Acreage, California Lemons, 1940–1949

County	Average yield per acre	Per cent of state lemon acreage	
		1940	1949
	1	2	3
	packed boxes		
Ventura	252	22.7	30.4
Santa Barbara	226	9.7	15.1
Los Angeles	219	21.2	18.4
San Bernardino	192	10.0	9.8
Riverside	192	6.6	5.6
Orange	170	13.8	8.9
San Diego	160	12.6	9.3
State average	216	....	....

but perhaps of equal significance is the effect of the maintenance of standing acreage. Since lemon trees, under appropriate care and cultural practices, have a very long bearing life, the change in age distribution which has developed in recent years may have only a limited effect on average yields in the next few years. But with fewer very young trees, reflecting a heavy reduction in plantings in recent years, there is developing a situation where sufficient young stock may not be available to come into bearing and offset removals. It is believed that at least 10 to 12 per cent of total lemon acreage is required to be of nonbearing age in order to offset losses due to age and disease, and to maintain a constant acreage of bearing trees. 1950 nonbearing acreage was in the neighborhood of 11 per cent of total acreage. Without additional plantings to offset removals for various reasons in the next several years, lemon-bearing acreage may decrease.

Production. Ninety-seven per cent of the lemons produced in the United States are grown in California. Production was

California Lemon Acreage, by Age of Trees, 1939 and 1949

Year	Age group in years					Total
	Less than 7	7–11	12–16	17–21	Over 22	
	1	2	3	4	5	6
1940						
Acres	17,315	16,194	4,319	3,770	27,092	68,690
Per cent	25	24	6	6	39	100
1950						
Acres	7,908	6,729	12,484	10,945	23,613	61,679
Per cent	13	11	20	18	38	100

generally increasing during the period from the beginning of commercial lemon production in about 1875 until 1940. Since 1940, production has decreased. However, California production in 1949–50 was still nearly three times the production of 1919–20. Production in 1949–50 was 11,500,000 boxes, or about 28 lemons per year for every person in the United States.

The changes in production have occurred in three rather distinct steps: During the period 1919–20 through 1936–37, the trend was gradually upward. Acreage was being expanded and production steadily increased as these additional trees came into bearing. In 1936–37 approximately 7,600,000 boxes were produced as compared to 4,500,000 in 1919–20. Beginning in 1937–38, production shot sharply upward and reached an all-time high of 17,236,000 boxes in 1940–41, when an unusually high yield was experienced. Plantings of lemons had been heavy during the late 1920's, and as this new acreage suddenly came into bearing, production increased rapidly. Since 1940–41, the trend has been downward, a low of 9,900,000 boxes being reached in 1948–49. During 1948–49 and 1949–50, unseasonably cold weather acted to reduce the expected volume of production.

California produces nearly half of the world's lemons; another quarter to a third are produced in Italy; and the remainder is distributed among a number of minor producing countries. World production in 1949–50 was estimated to be 23,300,000 packed boxes of which California produced 11,500,000 boxes; Italy, 6,100,000 boxes; and all other countries, 5,700,000 boxes.

In addition to the United States and Italy, other countries producing significant quantities of lemons are Argentina, Spain, Greece, Australia, Syria, Lebanon, and Algeria. Brazil was formerly included in the group of minor lemon-producing countries, but in recent years acreage has been extremely small.

Figure 3, below, shows the trend in lemon production for the world and the major producing areas through the years since 1919–20. As shown in figure 3, world production was generally increas-

Figure 3. World Lemon Production, by Major Producing Countries, from 1919–20.

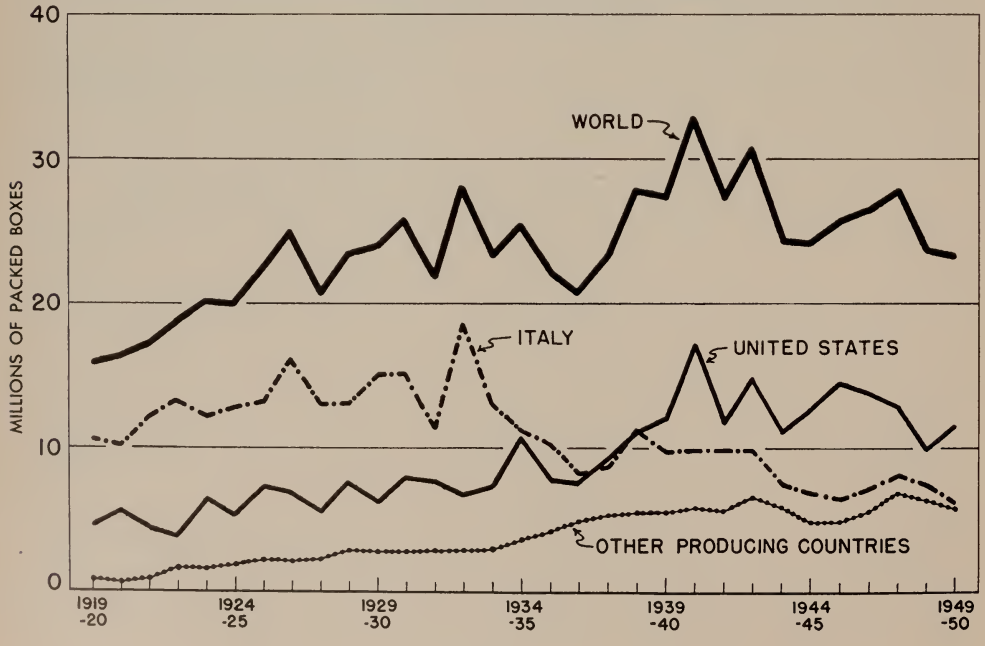
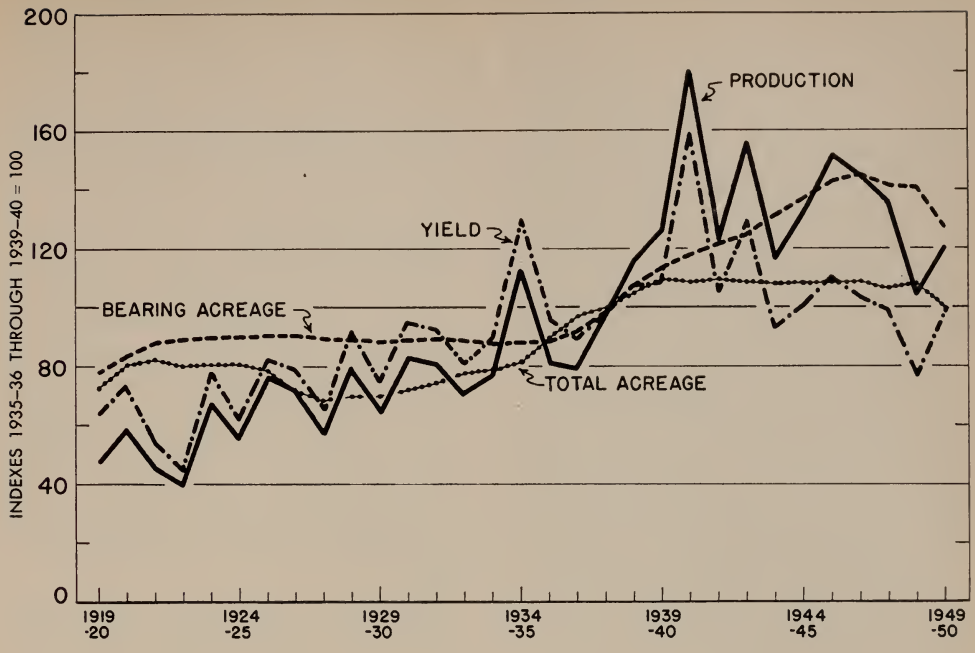


Figure 4. California Lemons: Production, Acreage, and Yield, from 1919–20.



ing from 1919–20 to 1940–41, to a peak of 32,942,000 packed boxes. Since that time, some reduction has taken place. Italian lemon production increased to a peak of 18,596,000 boxes in 1932–33 and then dropped sharply, for the next several years; since 1938–39, the trend has been downward. California production increased steadily up to 1937–38, rose sharply to a peak in 1940–41, and has declined somewhat since that year. Production in the minor lemon-growing countries has increased rather steadily over the entire period since 1919–20, from a volume of about 700,000 packed boxes in that year to a peak of 6,900,000 packed boxes in 1947–48. The aggregate production of these minor areas is now nearly equal in importance to the Italian lemon crop.

The relative importance of the areas of lemon production is undergoing a change. The positions of Italy and California have been reversed when compared to the period just after World War I, and the aggregate importance of the minor areas of production has been steadily increasing. In the period just after World War I, Italy was producing about 70 per cent of the world's lemons, California about 25 per cent, and the other countries the remaining 5 per cent. The shift in positions has occurred rather gradually over the period since 1919.

In California production, shifts have occurred among the 7-county group of major producers. Ventura is outstanding in its advance, in contrast with the other counties. Santa Barbara reflects only a slightly rising trend, although its proportion has decreased during the past several years. The remaining counties show either a stable or slightly declining trend in proportionate production.

Comparison of Acreage, Yield, and Production. With the preceding summary highlights of trends in acreage, yield and production, it is time to consider their interrelationships, with a view toward explaining the extent to which production changes are accounted for by acreage changes, in contrast with variations in yield.

Figure 4, above, shows, for the period

starting in 1919, annual index numbers for production, yield, and acreage of California lemons. The comparative trends of the several series indicate how lemon production has been influenced by acreage and yields, respectively. Total acreage, after rising for the first several years, leveled off for a short period and then declined between 1925 and 1927. Thereafter, a gradual increase developed and continued through 1939. For the next 10 years, total acreage remained remarkably stable until 1949–50, when a reduction occurred.* In contrast, bearing acreage which enters into the determination of production, after rising for several years, leveled off and remained stable for about 15 years until 1936; the dip in total acreage which began in 1925 and then recovered did not occur in the bearing acreage. After 1936, bearing acres began an upward trend that continued into the 1940's; thereafter, the trend in bearing acreage did not increase. Hence, substantial plantings occurred during the middle 1920's; during the latter half of the 1940's, plantings were not sufficient to maintain total acreage.

Average yield per bearing acre over the period since 1919–20 followed an upward trend during the first two decades. After the peak, which occurred in 1940–41, the yield receded but remained above the levels which existed prior to the middle 1930's. Year-to-year swings have occurred in the yield, and such swings are sharply reflected in the annual changes in production. The long-time trend in production reflects the corresponding trend in bearing acreage; the year-to-year changes in production reflect the annual changes in yield.

It is clear, from the above, and from figure 4, that the production growth from 1919 through the middle of the 1930's was accounted for by the upward trend in yield during that period. During the latter half of the 1930's, the production increase reflected both improved yields and more acres in bearing. From 1940 through 1946, however, the increased bearing acreage was generally more than offset by a declining trend in yields; and after 1946, both the bearing acreage and yield tended to decline, resulting in the production decrease.

Picking and Storage of Lemons. Thus far, discussion has been concerned primarily with lemon production and some of the basic factors underlying it. But production, as such, is only one phase of the producer-consumer pipe line. The lemons must be harvested. In addition, practices include storage before shipment. It is necessary, therefore, to review the situation in lemon picking and storage.

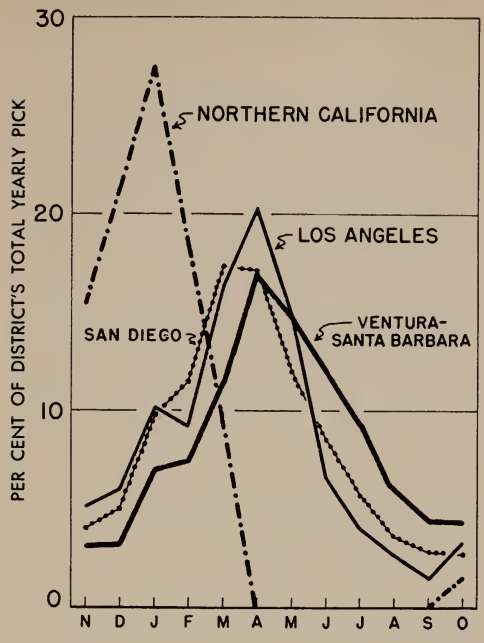
Lemons are harvested throughout the entire year. The harvesting season starts in November and gets fully under way in December. Picking then increases rapidly to a peak in April. The monthly volume picked then decreases rapidly until about August, when it levels off and continues low through September and October.

Rate of picking varies seasonally among the four major lemon-producing districts within California. These four districts (Ventura-Santa Barbara, Los Angeles, San Diego, and northern California) may be considered separately since conditions of production are somewhat different in each.

Picking in the Ventura-Santa Barbara and Los Angeles areas follows in general the same seasonal pattern, both areas reaching a peak in their picking in April (fig. 5, p. 15). However, the Los Angeles area tends to pick a greater portion of its fruit during the winter months (November–April) than does Ventura-Santa Barbara. The Los Angeles area normally picks about two-thirds of its fruit during these winter months, while Ventura picks

* In 1949–50, a lemon tree count was made, and served as the basis for suggesting the reduced acreage standing in that year. The acreage probably decreased over a period of years rather than dropping suddenly as shown in the published acreage figures, but no revisions were made for the years prior to 1949–50.

Figure 5. Seasonal Variation in Lemon Picking, by Producing Districts in California.



but half. Picking in the Los Angeles area decreases rapidly during May, and from June through October only about 15 per cent of the year's crop is harvested. Ventura-Santa Barbara continues picking at a heavier rate and harvests about 35 per cent of its season's total from June through October.

San Diego follows a middle path, harvesting almost as much of its crop as early as Los Angeles, but continuing picking on a relatively stronger basis throughout the remainder of the year.

Picking in the northern California area is done primarily during the early season. With the opening of the season in November, picking rapidly increases to a peak in January and then declines in a like manner through March. Very little fruit is harvested through the summer months until a limited preseason picking operation opens some time in September.

The relative picking rates of each of the lemon producing areas throughout the year are shown in the table below. The Los Angeles district picks the major share of the total during the winter months. During the November–April period, the Los Angeles district picks half of the state total; the Ventura-Santa Barbara district about 38 per cent; San

Percentage of Total California Lemon Picks from Each Producing District, by Months, Average of Period 1940–41 to 1949–50

Month	Los Angeles	Ventura–Santa Barbara	San Diego	Northern California	Total state percentage of year's total
	Percentage of state total				
November	54.1	35.4	7.1	3.4	4.2
December	53.0	32.8	9.8	4.4	4.5
January	50.8	35.1	10.4	3.7	8.7
February	49.3	35.6	12.7	2.4	8.4
March	46.6	42.2	10.4	0.8	14.2
April	47.7	44.3	8.0	....	18.7
May	42.5	51.1	6.4	....	14.6
June	27.2	65.1	7.1	....	9.9
July	25.7	66.8	7.5	....	6.4
August	19.2	74.4	6.4	....	4.0
September	18.7	74.1	7.2	....	3.0
October	36.7	55.2	7.5	0.6	3.4
Year	41.9	48.6	8.5	1.0	100.0

Diego about 10 per cent; and northern California about 2 per cent. As the winter progresses, picking in the Ventura-Santa Barbara district increases, until from May through October this area accounts for nearly 65 per cent of the total pick. In August nearly three-fourths of the total pick comes from the Ventura-Santa Barbara district. From May through October, the Los Angeles district picks 28 per cent of the total, and San Diego the remaining 7 per cent. Picking in the northern California district does not get under way until some time in October; the volume picked is less than 1 per cent of the state total during the summer period.

Although the time and rate of picking are determined in large part by natural factors which affect the condition of the fruit, growers have considerable latitude. Picking may be deferred to some extent depending on market and storage conditions. To the extent that picking is deferred, the lemons are stored on the trees. Hence, the picking operations are not independent of storage.

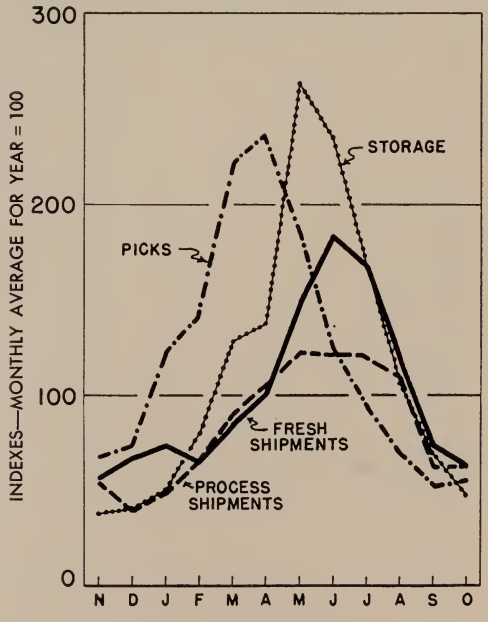
Half of the California lemon crop is harvested during the three months, March, April, and May. The period of heaviest shipment for fresh use and consumption, however, occurs in May, June, and July. This necessitates the storage of a large amount of fruit. In addition, the seasonal pattern of consumption is more uniform than the seasonal pattern of picking. This further induces storage. Storage is also required to hold lemons during the "curing" process. Adequate storage benefits both producers and consumers by making possible partial stabilization of supplies and improvement of the quality of the lemons marketed. The quality improvement comes about because considerably more juice can be obtained from a cured lemon than from one just picked.

The volume of lemons in storage as of November 1 fluctuated widely over the period 1919–50, varying from a low of 204,000 boxes in 1921 to a high of 1,285,000 boxes in 1940. Prior to World War II, there appeared to be a tendency toward a three-to-five year cycle in volume in storage.

As may be expected, the volume of lemons held in storage is influenced by market prices. There is a noticeable negative relationship between the winter-summer lemon price ratio and volume in storage. When summer lemon prices are high relative to prices of the previous winter, November 1 storage is relatively small and vice versa. There is also a general tendency for storage to be higher in years of extremely high production and lower in years of extremely low production. However, only the extremes in production influence level of storage.

Seasonal volume of lemons in storage is directly related to seasonal volume of picking and shipments (fig. 6, below). The bulk of the year's crop is picked during the spring months while heaviest volume of shipments occurs during the summer. At the opening of the lemon marketing season in November, storage is at a seasonal low. Volume in storage

Figure 6. Seasonal Variation in California Lemon Operations; Picks, Storage, Shipments to Fresh Market and Processing.



continues generally low through December. Beginning late in December, the volume of picking increases rapidly while shipments continue at a relatively low level. Consequently, the volume in storage begins to increase rapidly. This situation continues through April. In April, picking reaches its peak, and while shipments are increasing, their rate of increase is less than the rate of increase in volume picked. In the latter part of April, shipments begin to increase rapidly while volume of picking declines. Storage still increases, but the rate of increase is about half that of the previous month. The peak in storage is reached in May. For the rest of the season, shipments continue at a greater relative rate than pickings, and relative volume in storage decreases. Hence, storage of lemons, in addition to "curing" them to improve their quality, serves as a valve connecting and regulating the flow from picking to packing and shipping for some uses.

Costs of Production and Harvesting. All fruit harvested, whether it moves into fresh fruit or processing channels, incurs certain common costs. The separation of the fruit into fresh and processed channels generally takes place at the packing house and all fruit delivered

Average Costs of Producing and Harvesting California Lemons, Average by Periods, 1923–1948 and 1949

Cost items	1923–1930	1931–1939	1940–1943	1944–1948	1949
	Average cost per acre				
Fertilizer	$ 49.16	$ 31.01	$ 26.74	$ 55.45	$ 45.31
Water	31.47	29.68	20.22	32.47	35.76
Pest control	26.78	33.23	31.98	82.50	69.60
Frost protection	12.87	14.77*	8.22	32.40	104.66
Cultivating and irrigating	63.64	43.78	32.63	51.91	56.62
Pruning and tree care	16.82	14.38	16.93	31.43	33.57
Other materials	1.62	.40	3.19	5.33	6.61
Other labor	3.01	4.34	9.01	26.54	24.34
General expense†	22.81	22.38	17.52	22.73	38.98
Taxes	21.55	19.83	18.59	27.68	34.01
Insurance	1.32	1.74	1.55	4.08	4.00
Maintenance and repairs	8.42	6.76	4.97	8.92	14.57
Depreciation, buildings and equipment	17.92	16.16	16.37	16.40	16.98
Total cost per acre‡	$ 277.39	$ 238.46	$ 207.92	$ 322.07	$ 428.40
	Average cost per packed box				
Cultural cost	$ 1.63	$ 1.27	$ 1.01	$ 1.22	$ 1.94
Picking	.40	.32	.36	.59	.68
Hauling	.06	.05	.05	.07	.07
Cost at packing house door	$ 2.09	$ 1.64	$ 1.42	$ 1.88	$ 2.69

* 1937 omitted from average (bad freeze).
† Includes administrative and superintendence expenses.
‡ The average cost shown for each individual cultural operation represents the cost reported only by growers who performed that particular operation, and does not represent the average per-acre cost for all growers, including those who did not perform that particular operation.
Source of data: California Citrus League.

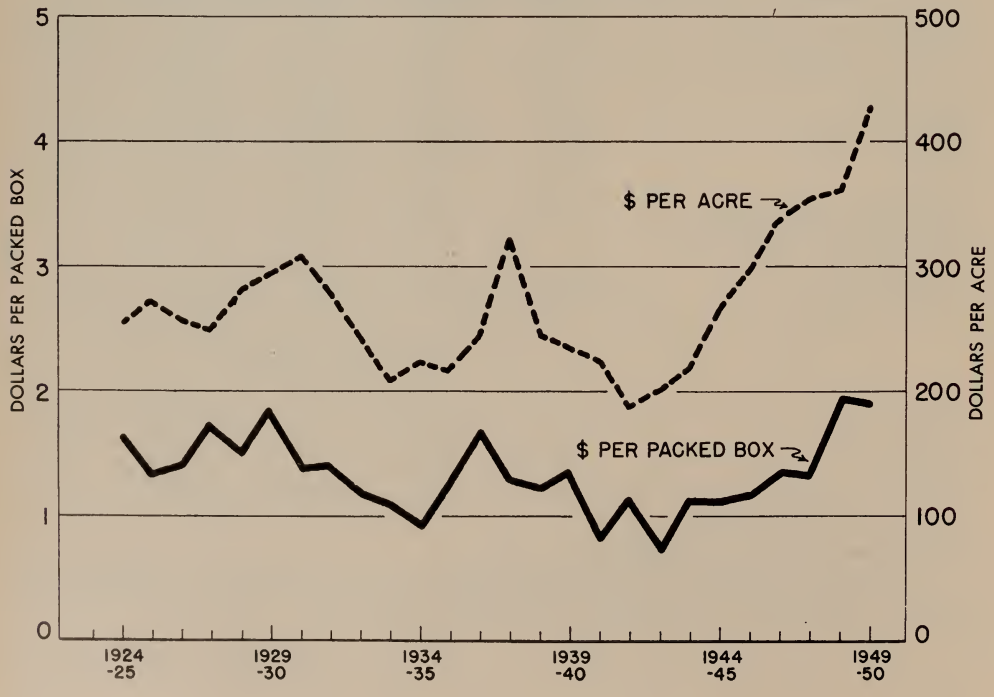
to the packing house door has already accumulated costs of production, picking, and hauling from the grove to the packing house.

The table on page 17 shows estimated changes in these costs which have occurred since 1923. During that period the national economy has moved from relative prosperity and peace during the late 1920's, through the depression of the 1930's, and into the wartime inflation of the latter 1940's. The estimated average costs, following the general price level, have in part reflected the cyclical swings in the economy. Total cultural costs per acre were relatively high during the period 1923–30, then generally declined through the 1930's, and reached a low in 1941. With the pressure of World War II, the costs began to rise and have increased rapidly since 1944.

There has been some variation in the relative changes occurring in the various items of cultural costs over this period. Certain items have increased more than others. During the period 1923–30, cost of pest control averaged $26.78 per acre. Over the five years 1944–48, it averaged $82.50. Frost protection has become a more important item than formerly. The years from 1947 through 1950 had cold winters; more heating in the groves was necessary, and the cost of oil was higher. Pruning and tree care have also become a larger cost item, the 1944–48 average cost being $31.43 as compared to $16.82 during the period 1923–30. Higher labor costs and the necessity for pruning caused by freeze damage combined to raise this item. The greatest relative increase has been in "other labor." Cost of "other labor" in 1923–30 averaged $3.01 per acre. During 1944–48, it averaged $26.54 per acre. Most of this increase has resulted from the advance in wages of agricultural labor during World War II. Smaller increases have occurred in taxes, materials, and insurance.

Several items have not increased as much as might have been expected. Fertilizer costs were higher, but the increase was only about 10 per cent. Water costs

Figure 7. Cultural Costs for Producing Lemons in California, from 1924–25.



per acre remained almost steady. Cultivating and irrigating costs actually decreased. General expense, including administration and superintendence, remained steady. Maintenance and repairs remained steady. Depreciation allowed decreased slightly.

Harvesting costs increased, mostly reflected in the picking operation. Higher labor rates increased cost of picking from $.40 per packed box from 1923–30 to $.68 per packed box during the 1944–49 period.

The estimated average costs noted above are on a "per-acre" basis. As explained earlier, yields per bearing acre have changed over the years. Hence, cost estimates on a "per packed box" basis are appropriate for consideration. Such estimates are shown in figure 7, page 18. The upward trend in yield through 1940 helped to reduce the costs on a per-box basis, but the decreasing trend in yield since 1940 has had an opposite effect.

The costs referred to are averages, which reflect the operations of a large group of producers. They cannot claim to be precise nor representative of all producing districts. Some growers undoubtedly have experienced lower costs, while other producers have been faced with higher. Yet the year-to-year changes may be considered as indicative of the general cost situation in the lemon producing districts. Viewed in that light, rather than as accurate measures, they are suggestive and helpful.

Utilization. Through the years, the larger part of the lemon crop has been shipped for fresh use. The lemon processing industry has operated primarily as a by-product operation, using that volume of fruit which could not find a profitable market in fresh channels of trade.

In recent years new developments, such as frozen lemonade concentrate, appear to be bringing about a change of the relative importance of the market for processed lemon products. The increased relative importance of the lemon processing industry has resulted more from an increase in the dollar value of the processed products rather than from an increase in the total volume of lemons processed. The change reflects a shift toward increased production of the more valuable lemon products, such as the frozen concentrates, and a decreased relative production of low-value products such as citric acid.

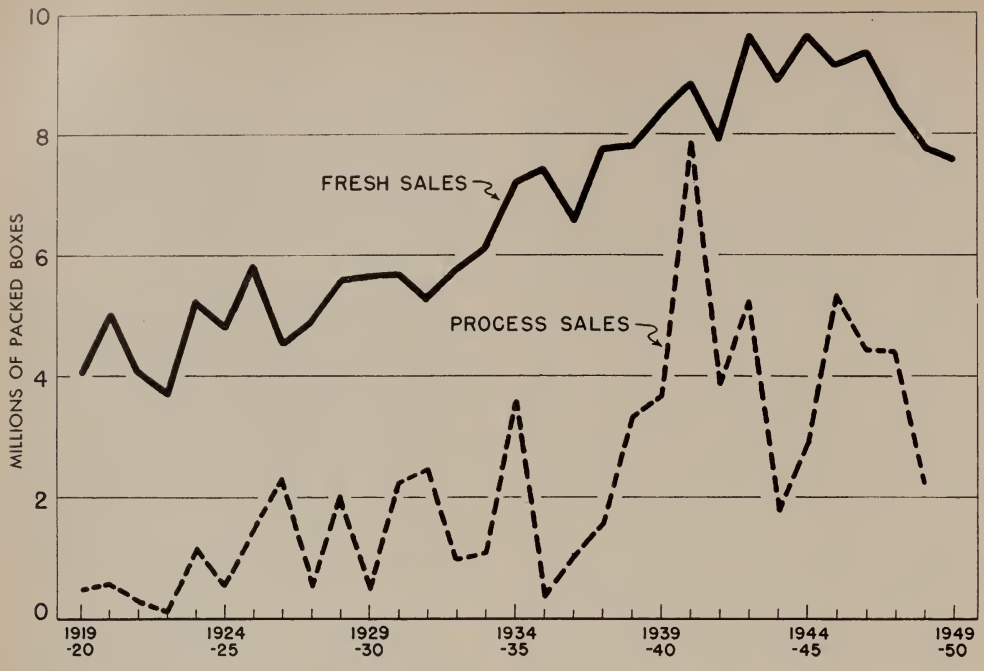
Figure 8, page 20, shows the changes in the sales of California lemons, both fresh and processed, over the period since 1919. As indicated, the trend in volume of lemons moving into fresh consumption was generally upward, reaching a peak in 1942–43. In 1940–41, processed lemons reached their peak. During the past five years, the sales volume of both fresh and processed fruit has tended to follow a downward trend.

A significant relationship evident in figure 8 is the difference in the amount of year-to-year variation in sales of fresh lemons as compared to variation in sales of lemons for processing. The volume of fruit moving into processing outlets varies much more from year to year than does that volume of fruit going to fresh sales. During the period 1919–20 through 1949–50, the average change in fresh sales of lemons from one year to the next was but 11 per cent; the average change in the volume of lemons sold for processing was 130 per cent.

Another significant relationship concerns the percentage of the total lemon crop that was processed and the actual volume of lemons moving into processed channels. The percentage processed changes very much like the actual volume processed. This occurs because the fresh sales are relatively uniform from year to year, and the excess production—that over the fresh sales—moves almost entirely into processed channels.

The volume of lemons processed tends also to vary with the size of the crop; the larger the crop, the greater the percentage of the total crop processed. For a

Figure 8. Utilization of California Lemons; Fresh and Processed, from 1919–20.



crop within the range of 9 to 14 million boxes, an increase in total crop of 1 million boxes has on the average been accompanied by an increase of about 3 to 5 per cent in the proportion of the total crop moved into processing channels.

The distribution of the lemon crop between fresh and processed uses is a problem of major significance to the lemon industry. Because of the nature of the demand for fresh lemons (which will be discussed in the next section of this report), with given purchasing power and income, there is a limit beyond which increased fresh sales will not result in greater gross money returns. Hence, there is the question of how the "excess" supply can be utilized. In other terms, because the lemon crop can be utilized and marketed in alternative forms, a significant marketing problem is related to the distribution of the lemon crop among alternative utilizations. The third major section of this report is concerned with such questions. But additional background must be provided here.

Fresh Shipments. Volume of fresh shipments of California lemons increased steadily from the earliest days of the industry until 1942–43. In 1907–08, 1.6 million boxes of California lemons were shipped for fresh sale. In 1942–43, 9.7 million boxes were moved. Fresh shipments continued at a high level during World War II, but decreased after the end of the war. In 1946–47, 9.4 million boxes were shipped; in 1947–48, 8.5 million; 1948–49, 7.6 million; and in 1949–50, 7.4 million.

As an average over the years, almost 95 per cent of the fresh lemon shipments moved into domestic consumption, only 5 per cent being exported. Of the lemons exported, about 70 per cent went to Canada. During World War II, however, many of the foreign markets were no longer accessible, and during the period 1940–46, about 95 per cent of the lemons exported were sent to Canada. The proportion to Canada has declined since the war years, and in 1949–50 dropped sharply to about half of total exports of fresh lemons.

Seasonal Variation in Fresh Lemon Shipments. There is a pronounced and regular seasonal pattern in the volume of fresh lemon shipments (see fig. 6, page 16). At the opening of the marketing year in November, shipments are at a seasonal low. Volume builds up steadily until May, increases rapidly to a peak in June, remains high during July, and then drops off rapidly during the remainder of the year.

There is some difference in the timing of shipments from the various producing areas within the state (fig. 9, below). The northern California area ships practically all of its fruit during the six months, November through April. Shipments increase to a peak in January and then decline rapidly. Very little fruit is shipped from this district during the summer months, but shipments are resumed on a small scale late in September or early in October.

The Los Angeles and San Diego districts both have the same general seasonal pattern of shipments. Movement of fresh fruit increases gradually from November to April and then at a faster rate, reaching a peak in June. Volume of shipments then declines steadily during the remainder of the season.

Figure 9. Seasonal Variation in California Fresh Lemon Shipments, by Producing Districts.

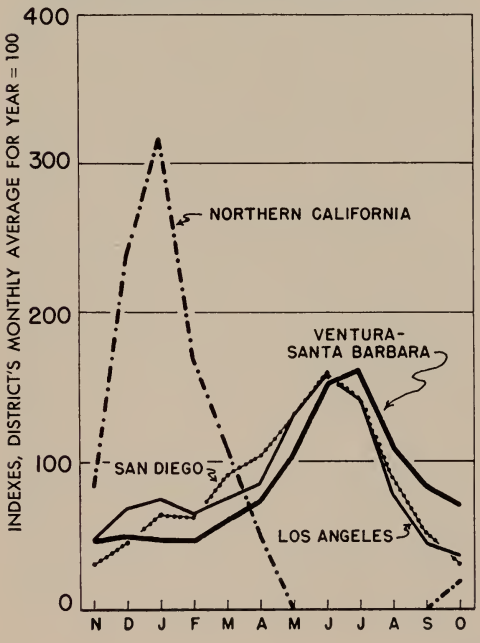
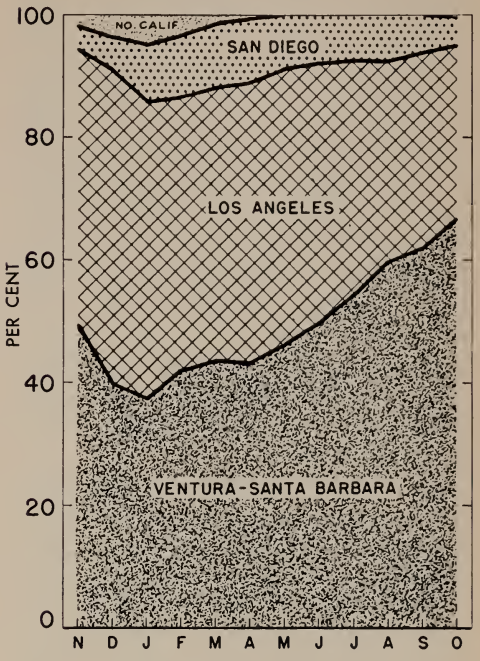


Figure 10. Percentage Distribution, by Months, of California Shipments of Fresh Lemons from Producing Districts.



Shipments from the Ventura-Santa Barbara district follow a pattern similar to that of Los Angeles and San Diego, but the movement tends to be more concentrated in the latter half of the season. During the period June through October, the Ventura-Santa Barbara district moves 58 per cent of its fruit, compared to 45 per cent moved from the Los Angeles and San Diego districts.

Figure 10, above, shows the relative importance of fresh shipments originating in each district throughout the year. Shipments from the northern California district are small and reach their greatest importance in January when 5 per cent of the state total is shipped from there.

The San Diego district ships about 8 per cent of the state's total. Volume from this district is greatest during January, February, and March, when slightly more

than 10 per cent of the state's total for these months comes from the area.

The Los Angeles district moves about 41 per cent of the state's fresh lemons. This area furnishes the most fruit during the months of December through April. In December, almost 52 per cent of the state's total fresh shipments originate in the Los Angeles area. During January, February, March, and April, this area continues to dominate, but its importance relative to the Ventura-Santa Barbara area diminishes steadily; in May, Ventura-Santa Barbara becomes the most important shipping area. During the last two months of the season, about two-thirds of the state's total fresh shipments come from that district.

Reference to figures 5 and 9, pages 15 and 21, indicates that the Ventura-Santa Barbara, Los Angeles, and San Diego districts have somewhat similar seasonal patterns of picking and fresh shipments, and a large degree of shipping-period overlapping exists. Interdistrict competition prevails, therefore, in the packing house sales of fresh lemons.

Imports of Lemons and Lemon Products. In contrast to the situation existing for oranges and grapefruit, imports of foreign lemons are an important factor influencing the domestic lemon market. For the past 20 years, a relatively high United States tariff, together with European wars, have combined to limit effectively the quantity of lemons which were imported by the United States. However, in 1950, the United States tariff on lemons for fresh consumption was cut in half. At the same time, political, agricultural, and economic conditions in foreign lemon producing areas—particularly Italy—were approaching a stage that would permit these areas to increase appreciably the volume of lemons which would be available for export.

The importance of securing American dollar exchange makes the American market particularly attractive to foreign competition. The amount of competition from foreign lemons is related to prevailing tariff duties. These duties, since 1897, have been as shown in the table below.

United States Import Duty on Fresh Lemons

Tariff act	Duty in cents per pound
1897	1.0
1909	1.5
1913	0.5*
1922	2.0
1930	2.5
1950	1.25†

* The actual rate was 35 cents per box which was approximately equivalent to 0.5 cents per pound.
† The United States government reserves the right to increase the rate to 2.5 cents per pound on lemons which are entered in any calendar year in excess of an aggregate quantity by weight equal to 5 per cent of the production of lemons in the United States during the preceding calendar year.

In the early years of the United States lemon industry, production was relatively limited. Imports helped to meet the domestic demand for this fruit, and growers generally were not particularly concerned with the impact of lemon imports. During this early period, prior to World War I, the fresh lemon markets west of the Mississippi River were supplied chiefly with California lemons; the region north of the Ohio River and east of the Mississippi was a market in which foreign and domestic lemons were highly competitive; and the South Central and Atlantic Seaboard states were supplied in significant part by foreign lemons. World War I materially reduced the importation of foreign lemons, although a relatively substantial volume continued to come into the country. During the war period, the increased California production found profitable markets in the East and in the South Atlantic states. With the re-establishment of more normal international trading conditions after World War I, lemon imports into this country did not regain their earlier volume.

Foreign production conditions, the recovery of the European markets, and increased tariff for fresh lemon importations, as well as the pressure of domestic production, combined to make a situation wherein foreign exports of lemons to the United States tended to decline. In 1930, the tariff was raised again and its effect, along with other conditions, resulted in small lemon imports during the 1930's. This situation continued until 1950 when the tariff reduction of 50 per cent and the need for dollar exchange encouraged increased lemon exports from Italy.

The current situation with respect to the importation of fresh lemons differs from that prevailing at the end of World War I or in the following decade. Supply conditions now are quite different. Domestic production in 1950 totaled nearly 12 million boxes of which the domestic market took about 8 million boxes as fresh fruit. The importation of lemons on a scale comparable to that of the 1920's—a million to a million and a half boxes per year—would result in either much greater supply pressure on the summer lemon market, or a reallocation between summer lemons for fresh market and for processing. An increment of a million boxes to the fresh lemon summer market, with no reallocation of domestic summer lemon supply to processing, would decrease returns to a level which in many cases would be insufficient to cover harvesting, handling, and transportation costs.

Imports of fresh lemons into the United States were generally decreasing over the 40-year period ending in 1945–46. Since that time the trend has been slightly upward; the 1949–50 and 1950–51 seasons will be years of heaviest imports since 1930.

Several factors may be considered as contributing to the general decline in the imports of fresh lemons until the past year or two. A major factor was the great increase in United States lemon production which occurred during the 1920's and 1930's. In this period, the United States changed from a deficit area of lemon production to one which harvested annually more than sufficient lemons to meet domestic needs. As a result, increased competition of California lemons, particularly in the Atlantic Seaboard market, reduced the demand for the imported fruit. A second factor was the changes in the United States tariff duty on fresh lemons. As seen in the table on page 22, the duty on this fruit, with the exception of the period 1913–22, was becoming greater with each new tariff act. This discouraged importation. The third factor which reduced the importation of lemons was the prevalence of economic and political disturbances during the period considered. Included were two world wars, a major business depression, and a violent change in the government of Italy, from which country come practically all of our fresh lemon imports.

The relatively marked upsurge in fresh lemon imports since 1948–1949 was accounted for by several factors. One was the 50 per cent reduction of the import duty made effective in 1950. Another was the demand for dollar exchange in Italy, which encouraged the channeling of Italian lemon production into this country in contrast with European markets. A third factor of some significance was the domestic price level reflecting an economy subjected to inflationary pressures. In foreign exchange terms, summer lemon prices on the Eastern Seaboard have been attractive to Italian lemon exporters. These three factors, in combination, have resulted in a situation where lemon imports are now again beginning to approach a level where they are of concern to domestic producers and shippers of lemons.

Although fresh lemon importations occur throughout the year, the large bulk in earlier years came in during the summer months. The period of most heavy imports in the past was in May, June, and July. In fact, almost 60 per cent of total

annual imports were unloaded during those three months. Since the end of the war, however, most of the imports have occurred during the winter months. Aside from the seasonal timing of imports, the domestic market for fresh lemons is again faced with increased supplies of imported fresh lemons and lemon juice as well as the developing market for canned lemon juice and frozen lemonade concentrate.

The United States domestic market receives imports of various processed lemon products. They include lemon juice and lemon oil as well as some quantities of citric acid and lemon peel (crude and candied). Most of the imported lemon oil—over 90 per cent—originates in Italy. The crude and candied lemon peel also comes mainly from Italy, although some was obtained from Spain during the war years.

The importations of processed lemon products have generally followed a declining trend during the past several decades. In the past several years, imports of lemon oil have reflected a tendency toward recovery. The earlier levels have not yet been regained, however.

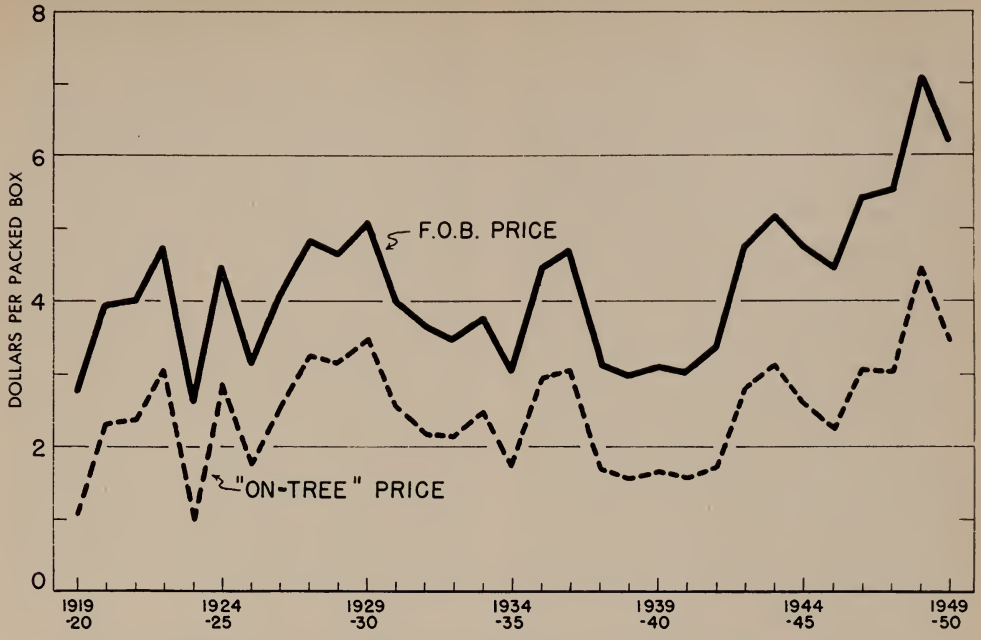
The factors underlying the imports of processed lemon products are largely the same as those of fresh lemon imports mentioned earlier.* The year-to-year variation tends to be more pronounced in the processed products than in the fresh lemon imports. This is characteristic especially of citric acid, and to a considerable extent for lemon peel.

With the apparent restoration of lemon production in Italy and other Mediterranean countries, their strong desire for dollar exchange and purchasing power in dollars, as well as the recent reduction in the import tariff rate, increased exports of lemons and lemon products to the United States market are taking place. From the views of the growers, shippers and processors in this country, however, potential developments are even more significant than the present status. The importation of an additional half-million boxes of lemons, for example, and their impact on the Eastern Seaboard markets (such as New York, Boston, and Baltimore) would not only adversely affect the prices in those cities but in others as well, because of the intermarket price relations. The importation of 734,000 gallons of concentrated lemon juice (equivalent to 612 carloads of fresh lemons) in 1950 caused much concern in the domestic lemon industry.

In the eyes of California lemon growers, shippers, and processors, the prospect of additional lemon and lemon product imports is considered as a real threat to their markets and income. In the eyes of consumers, the prospect of such imports is considered as contributing toward lower prices. From the over-all national view, consideration must be given to the relative interests of all groups in the economy. Important to consumers as well as to the national interests, too, is the factor of stability in the flow of supplies to the consuming markets. Highly sporadic and fluctuating imports, from year to year, do not contribute to stability in supply. To that extent, highly variable imports, as have occurred in fresh lemons and processed lemon products, lend instability to the lemon markets. Such instability is conducive to uncertainties in both supply and demand as well as in price, and accordingly may adversely affect the interests of consumers as well as producers. Although the situation is not similar in all respects to dumping, its effects are largely the same as those which result from sporadic and short-run dumping practices.

* The Tariff Act of 1950 reduced the import duties on lemon products as well as fresh lemons. The changes from the 1930 to 1950 Acts on several lemon products are as follows: lemon oil, from 25 per cent *ad val.* to 17½ per cent *ad val.*; lemon juice, from 70 cents per gallon to 35 cents per gallon (on the unconcentrated natural juice content); crude lemon peel, from 2 cents per pound to 1 cent per pound; candied lemon peel, from 8 cents per pound to 6 cents per pound.

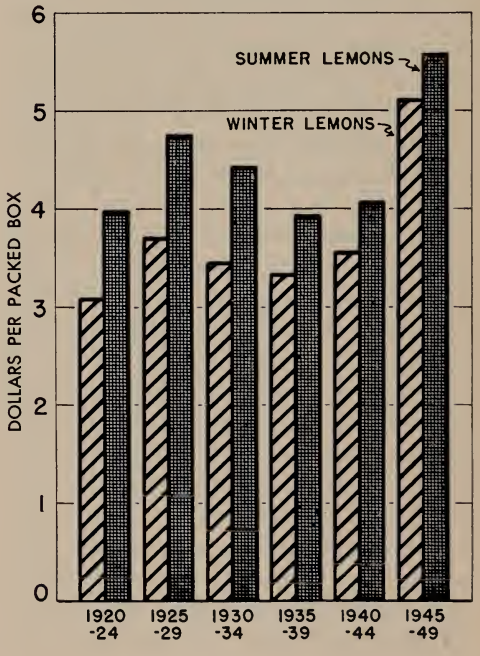
Figure 11. Prices of California Lemons Shipped for Fresh Use, F.O.B. and On-Tree, from 1919–20.



F.O.B. Prices of Fresh Lemons. During the period 1919–45 the price of California lemons for fresh consumption moved erratically from year to year (fig. 11, above). The f.o.b. price of California lemons fluctuated within a range of from $3.00 to $5.00 per packed box, and the "on-tree" price varied from about $1.00 to $3.00 per box. Prices were relatively low during the period 1937 through 1940, the f.o.b. price remaining near the $3.00 level during these four years. This relatively low price in part reflected the substantial increase in the volume of production and fresh shipments. Beginning in 1946, lemon prices reflected the inflationary trend. The high prices of 1948–49 and 1949–50 reflected in large part the effects of the two major freezes in those years.

The spread between f.o.b. and on-tree prices reflects the approximate cost of picking, hauling, packing, selling, and advertising. During the period 1919–40, this cost remained at a remarkably uniform level. During this 21-year period the spread stayed at a level of about $1.50 per packed box, varying from $1.30 to $1.65. After 1940, both costs and f.o.b. prices increased rapidly, with the latter increasing the greater amount. Hence,

Figure 12. F.O.B. Prices of California Fresh Lemon Shipments, Summer and Winter, Five-Year Averages from 1920.



the spread widened, and it is clear that on-tree to f.o.b. marketing expenses have increased during the past decade.

Summer lemons (May–October) normally sell for a higher price than winter (November–April) fruit, but during the past ten years the spread between these prices has tended to narrow (fig. 12, p. 25). During the 30 years 1919–49, the summer lemon price averaged 75 cents per box higher than the winter price. The five-year average spread in prices between summer and winter lemons has varied from a high of $1.04 per packed box f.o.b. during the period 1925–29 to a low of $.46 during 1945–49. Since 1925–29, the spread has steadily decreased. This decreasing spread may reflect an increase in lemons consumed during the winter months, resulting at least in part from industry advertising efforts toward increasing year-round use of lemons.

The price of fresh lemons has a rather consistent pattern of seasonal variation. Prices generally are at a seasonal low during the early spring, then begin to rise and increase rapidly to a peak in midsummer. As autumn approaches, prices begin to drop rapidly. When winter weather arrives, the price again advances before receding to its seasonal low in the early spring. The summer and winter peaks in lemon prices are related to the effects of temperature on the demand for fresh lemons. The influence of temperature is considered in some detail in the next section which discusses the nature of the demand for fresh lemons, both summer and winter.

II. DEMAND CHARACTERISTICS OF LEMONS

Introduction. The preceding section included a review of economic developments in the lemon and lemon products industries. Particular attention was focused on the trends in production and shipments of lemons for fresh consumption, on the trend of lemon imports into this country, and on the recent trends in the processed lemon products industries. Each of those developments, in an important manner, bears upon the marketing of the lemon crop and income derived from it.

The demand characteristics of lemons and lemon products serve as one of the major connecting links between the income from the lemon crop and the form in which this fruit is marketed. The nature of the demand for lemons and lemon products not only expresses the relation between quantities the markets will accept at various prices, but also indicates how the money income from the crop is affected by changes in the volume marketed. For that reason, it is necessary to consider the essential economic characteristics of the demand for lemons.

As helpful background, it is first necessary to express in adequate but convenient form just what is meant by "demand." Such a statement may then serve as an introduction to a consideration of how and why demand characteristics affect money income from marketing. In that connection, we will review the statistical evidence which points to the major economic characteristics of demand for lemons. A clear picture of what is meant by "demand" will help to make the statistical evidence more meaningful and the economic developments easier to interpret.

What Is "Demand"? The term "demand" is used widely and often loosely in marketing discussions. It is frequently used as equivalent to the quantity of a product, say lemons, which has been sold or the market has taken. A more acceptable and useful interpretation is that which refers to the relation between a schedule of prices and a corresponding schedule of quantities, both schedules pertaining to a particular product in a particular market. Hence, "demand" is

representative of various quantities of a product that would be purchased at various corresponding prices in a given market, at a given time, and under given conditions. Those given conditions include fixed tastes and preferences of buyers or potential buyers, fixed amounts of income or money available for expenditures on all goods, and fixed prices of other goods and services. Thus, in a strict sense, the "demand" for a particular product pertains to some given situation in which all influences, except price and quantity of the particular commodity, are given and fixed. In such a context it can be argued that for a given demand, price and quantity of the particular commodity vary inversely; the lower the price the larger the quantity that would be taken, the higher the price the smaller the quantity that would be taken. So are constructed demand schedules which are mathematically represented by demand equations and graphically pictured as demand curves. Always in the background of such demand curves, however, and influencing their shape and position, are the given conditions such as income and tastes of the buyers, prices of other products, and the characteristics of the particular market.

In the consideration of many problems in lemon marketing, the nature of the demand for lemons is of crucial importance. This arises for two reasons. First, there is the question as to how changes in quantity and changes in price are related for a given lemon demand situation represented by its corresponding demand schedule or demand curve. Second, there is the question as to how the lemon demand schedule as a whole responds to changes in the level of factors such as income and temperatures.

The relations between price changes and quantity changes, for a given demand schedule, are often expressed by the phrase, "elasticity of demand with respect to price," which we shall refer to briefly as "price-elasticity." In precise terms, price-elasticity at a point on the demand schedule measures the percentage change in quantity which occurs in response to the corresponding percentage change in price. In more specific terms, the price-elasticity equals the percentage change in quantity divided by the corresponding percentage change in price; the changes should be small since the price-elasticity coefficient pertains to the relationship at the price-quantity point from which the changes are considered. Therefore, the price-elasticity may, and usually does, vary from point to point on a given demand schedule.

When the absolute value of the price-elasticity coefficient is greater than one, at a certain point on the demand schedule, the demand is said to be "elastic" at the price-quantity combination at that point; when the absolute value of the price-elasticity coefficient is less than one at a certain point on the demand schedule, the demand is said to be "inelastic" at that point; and when the price-elasticity coefficient is equal to one, the demand is said to be of "unit elasticity."

When the price is the dependent variable, as in the analyses to be summarized below, for statistical reasons it is more appropriate to use an elasticity measure which is the inverse of the price-elasticity noted above. This other measure is referred to as "price-flexibility" and is equal to the relative change in price divided by the corresponding relative change in quantity. Hence, when the absolute value of the price-flexibility coefficient is less than one, at a particular point on the demand schedule, the demand is said to be "elastic" at that point; when the price-flexibility coefficient is equal to one, the demand is said to be of "unit elasticity"; and when the price-flexibility is greater than one, at a particular point of the demand schedule, the demand is said to be "inelastic" at that point.

Whether the demand is "elastic" or "inelastic" is of prime importance to marketing plans and decisions. The elasticity

nature of demand reflects the behavior of total money revenue from sales as they are increased or decreased.

Although it is not necessary here to prove the following relations, it can be shown that when the price and quantity change, on a given demand schedule, the resulting money revenue increases or decreases, depending upon the price-elasticity. When the demand is elastic at a given price-quantity combination on the demand schedule, a small decline in price results in an increase in total money revenue from sales; but when the demand is inelastic at a given price-quantity point, a small decline in price results in a decrease in total money revenue sales. Conversely, a small increase in price from an elastic point on the demand schedule results in a decrease in total revenue, and a small increase in price from an inelastic point on the demand schedule results in an increase in total money revenue from sales. Such effects of price and quantity changes on total revenue make it clear why it is helpful to have indications of the price-elasticity coefficients when considering marketing practices. With knowledge about the values of the price-elasticities for lemons, for example, one may draw inferences as to the money effects associated with the marketings of different quantities of lemons. For that reason, we shall later review the available statistical evidence bearing upon the price-elasticity coefficients for lemons.

It is well known that factors which affect the demand for lemons, such as income and temperature, do not remain constant; on the contrary, they change from year to year and sometimes vary widely. Such changes affect the position or level of the demand for lemons, and as the changes occur, the demand schedule shifts. For that reason, the demand-affecting factors are often referred to as "shift variables." Such "shift variables" are included in statistical analyses of factors affecting demand and prices. Consideration of the "shift variables" is necessary in the estimation of the demand or net relation between price and quantity in a given season. They are also needed in order to estimate how and why the demand schedule shifts position from season to season or over a period of years. The available statistical evidence on the influence of major shift variables will be reviewed later.

Demand for Fresh Lemons.* The available statistical evidence strongly suggests that the demand for lemons in this country is inelastic at the volume of marketings which have usually occurred in past years. The resulting indication is that if a somewhat smaller volume of lemons had been marketed than actually was marketed in given years, the gross money revenue would have been larger than it was in those years. This applies to lemons marketed for fresh consumption, the outlet for which there is considerable historical experience and which, by far, has been the most important in past years. But before considering the demand characteristics for processed lemon products, which have expanded sharply during the past several years, it is pertinent to review the statistical evidence pointing to the inelastic demand for fresh lemons.

The review of statistical evidence can advantageously consider summer lemons and winter lemons separately. Although the same general types of factors influence both summer and winter lemons, the differing characteristics of the two seasonal markets and the differential effects

* This and the following paragraphs on statistical analyses of demand for summer and winter fresh lemons is based upon the published and unpublished works of Dr. George M. Kuznets. Reference is made to Kuznets, G. M., and Lawrence R. Klein, "A Statistical Analysis of the Domestic Demand for Lemons, 1921–1941," (Giannini Foundation Mimeographed Report No. 84) June 1943; Kuznets, G. M., "Domestic Demand for Lemons," *California Agriculture*, Vol. 4, No. 10, Oct. 1950, p. 2; and various unpublished materials developed by Dr. Kuznets.

of the factors make it advisable to analyze them separately. Convenience in analysis, though, is not the only reason for considering summer and winter lemons separately; a more important reason is that the summer and winter seasons reflect different market characteristics.

Summer Lemons. Lemons which are marketed during the six-month period from May through October are commonly referred to as summer lemons. The warm and hot weather months for practically all of the states are included. This is noted here because, as will be indicated below, the maximum temperatures experienced during the summer months affect the demand and consumption of lemons.

The statistical evidence suggests that the demand for summer lemons at the f.o.b. level of marketing tends to be inelastic. The coefficient of price-flexibility has been greater than one for the majority of the years since 1922. As an indication of how the estimated annual coefficients of price-flexibility have varied, they are shown in the table below.

As a tendency for the whole period, the f.o.b. demand was slightly inelastic. When adjustments are made for picking and packing costs, the demand at the on-tree level of marketing definitely becomes inelastic. Explicit evidence on this point is noted later. Here, we intend only to indicate how the demand elasticity varies from year to year and what has been its general level.

The price elasticities for summer lemons, noted above, are derived from a statistical demand analysis. Thus, we may review the analysis and derivation of the demand equation in order to indicate its meaning. But first, it is necessary to consider the several variables included in the analysis. The variables include series of data on prices and quantities of summer lemons, the level of national nonagricultural income during the summer months as measured by an income index, and an index of summer temperatures. Each of the series used may now be explained in some detail.

The prices used in the analysis are average f.o.b. prices received by the California Fruit Growers Exchange for fresh lemon marketings during the period of May through October. It is presumed that

Fresh Summer Lemons at F.O.B. Marketing Level. Annual Coefficients of Price Flexibility, 1922–1949 (Excluding the War Years)

Year	Coefficients of price flexibility	Year	Coefficients of price flexibility
1922	−0.89	1935	−1.55
1923	−0.75	1936	−1.18
1924	−1.21	1937	−1.02
1925	−1.01	1938	−1.53
1926	−1.14	1939	−1.65
1927	−0.92	1940	−1.89
1928	−0.83	1941	−2.03
1929	−0.77		
1930	−0.85	war years	
1931	−1.03		
1932	−0.80	1947	−1.25
1933	−0.97	1948	−0.94
1934	−1.11	1949	−0.80

such prices are representative of industry average f.o.b. prices since the California Fruit Growers Exchange over the years has marketed in the neighborhood of 85 to 90 per cent of total domestic fresh lemon shipments. For the years beginning with 1926, the prices of lemons sold loose (unpacked) are included in the averages in order to reflect the growing importance of lemons sold loose. For 1936 through 1941, prices received from exported lemons are excluded from the averages. It is believed, however, that such differences do not significantly affect the year-to-year changes in the averages since a large proportion of the exports has gone to Canada for which the f.o.b. prices are usually highly correlated with those for domestic shipments. Here, also, it should be noted that the average prices reflect all sizes and grades as they were shipped.

The behavior over time of average f.o.b. prices is shown in panel A of figure 13, page 31. One can thus see that the prices have tended to fluctuate rather widely. During the prewar years, the f.o.b. price averaged close to $3.75 per box, with a slight downward trend evident. During the postwar years, the prices averaged higher than previously, reflecting an inflated price level for practically all goods and services—due in large part to the inflationary nature of the economy as a sequel to wartime developments. An essential feature of the price behavior, as evident from figure 13, is the marked annual variation of prices at the f.o.b. level. With relatively rigid tree-to-packing-house costs faced by the industry, one can infer that on-tree prices have varied from year to year even more than did the f.o.b. prices. The annual variation in these f.o.b. prices of summer lemons can be accounted for in most part by the variations which have occurred in certain other variables included in the analysis.

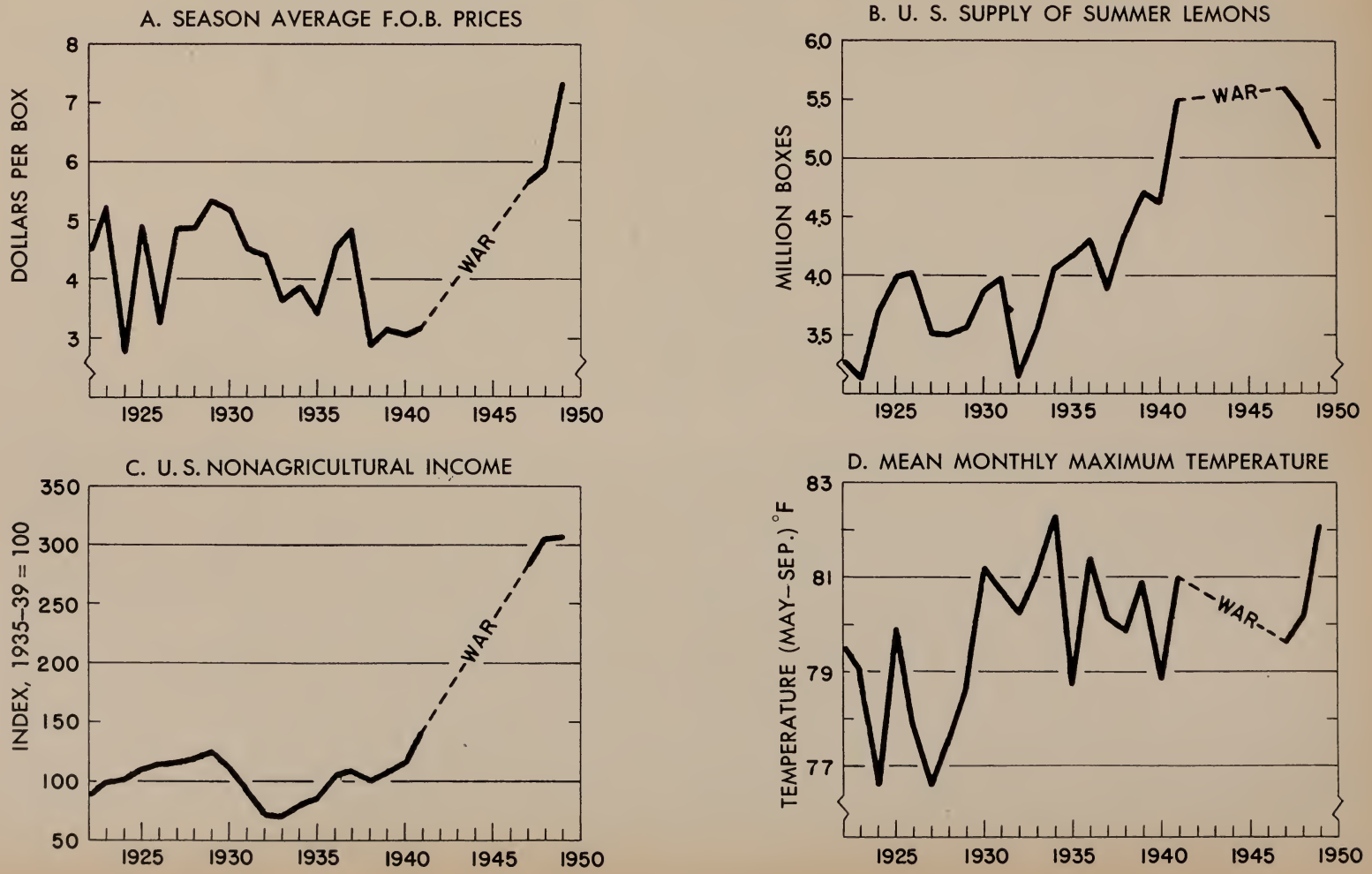
The United States level of supply of summer lemons is a second variable in the analysis. This supply was derived by adjusting total shipments for fresh consumption by the net difference between domestic exports and imports for consumption. In this manner, account is reflected of the influence of lemon imports which have been of significance in the summer months of various years.

The temporal behavior of the United States supply of summer lemons by years is shown graphically in panel B of figure 13. During the first ten years of the period under review, the supply varied widely about a level trend with an average of about 3.5 million boxes. Beginning at about the middle of the 1930's, though, the trend started to rise and did so sharply up to the beginning of World War II. The all-time peak was reached in 1947, the first postwar year included in the analysis, with a supply of almost 5.6 million boxes. There was some decline thereafter, but the level of supply remains much higher than that prevailing generally during the prewar years.

Another variable used in the analysis is the index of United States nonagricultural income payments during the May–October period. The index is based on averages of seasonally adjusted monthly estimates of nonagricultural income during the period summer lemons are marketed. The index may be considered as a measure of consumer purchasing power and is incorporated in the analysis to measure shifts in the demand for summer lemons due to changes in consumer money income.

The course of nonagricultural payments for the period beginning with 1922 is shown in panel C of figure 13. There is the rise during the 1920's to a peak in 1929, followed by the depression fall of the early 1930's and the low points of 1932 and 1933. Beginning with the 1934 season, the index began to rise again and so continued, but with an interruption in 1938; thereafter, the income advanced sharply and has continued to do so through the postwar years. It must be

Figure 13. Summer Fresh Lemons; Seasonal Average F.O.B. Prices and Factors Related to Them, 1922–1949.



noted here that the index reflects money income and thus reflects the postwar inflationary level of prices in general. If the index is adjusted so as to reflect real income, or what the money income could purchase in terms of goods and services, a postwar rise is evident but to a much less degree than in money income.

The fourth variable included in the analysis is an index of temperature in the summer lemon marketing period. The index is constructed from monthly mean maximum temperatures, May through September, in some 22 cities, with the respective temperature values weighted by 1931–38 average unloads of lemons in those cities for corresponding months. The values for the index since 1922 are shown in panel D of figure 13. The wide variations from year to year are evident. Also the existence of an upward trend in temperature may be noted during the period under review, with the trend rising somewhat sharply in the first half of the period but only very slightly during the latter half.

It is now time to review the relation between price changes and the other variables in the analysis. That may be approached by consideration of an equation which expresses the price as a function of the supply, income, temperature and "time" which is viewed as a proxy for those influences which have changed smoothly and persistently over time. Such an equation not only serves as a basis for explaining in a statistical sense the behavior of the prices, but may also serve as a basis for drawing inferences regarding the demand characteristics for summer lemons.

The statistical equation developed for summer lemons* may be interpreted as describing the following average relations prevalent during the period analyzed:

A change of 100,000 boxes in the supply of summer lemons, with other factors held constant, on the average was associated with an f.o.b. price change in the opposite direction of about 11.5 cents per box. This relation is shown in panel A of figure 14, page 33.

A change of 10 points in the index of nonagricultural income, with other factors held constant, on the average was associated with an f.o.b. price change in the same direction of about 32 cents per box. This relation is shown in panel B of figure 14.

A change of 1 point in the summer temperature index, with other factors held constant, on the average was associated with an f.o.b. price change in the same direction of about 31 cents per box. This relation is shown in panel C of figure 14.

The above average relations are shown graphically in figure 14, panels A, B, and C. In panel D of figure 14 is shown the estimated trend in the demand for summer lemons as it has shifted during the years. The points plotted about the net relation lines in panels A, B, C, and D of figure 14 are the differences between the actual prices and those estimated by the statistical equation for the respective years. The evidence suggests a tendency

* The following multiple regression equation for summer lemons was fitted to the data for the period beginning with 1922, but omitting the war years from 1942 through 1946:

$$X_{1s} = -19.3605 - \underset{(4.338)}{0.1148}\, X_{2s} + \underset{(6.668)}{0.0323}\, X_{3s} + \underset{(3.935)}{0.3103}\, X_{4s} - \underset{(2.510)}{0.0994}T - \underset{(2.419)}{0.0085}T^2$$

$\bar{R} = 0.915$; $n = 23$; and the figures in parentheses are t-ratios. Equation was fitted to data in table 2, page 70. Also see table 8, page 76.

X_{1s} = F.o.b. price of summer lemons for fresh consumption, in dollars per box.

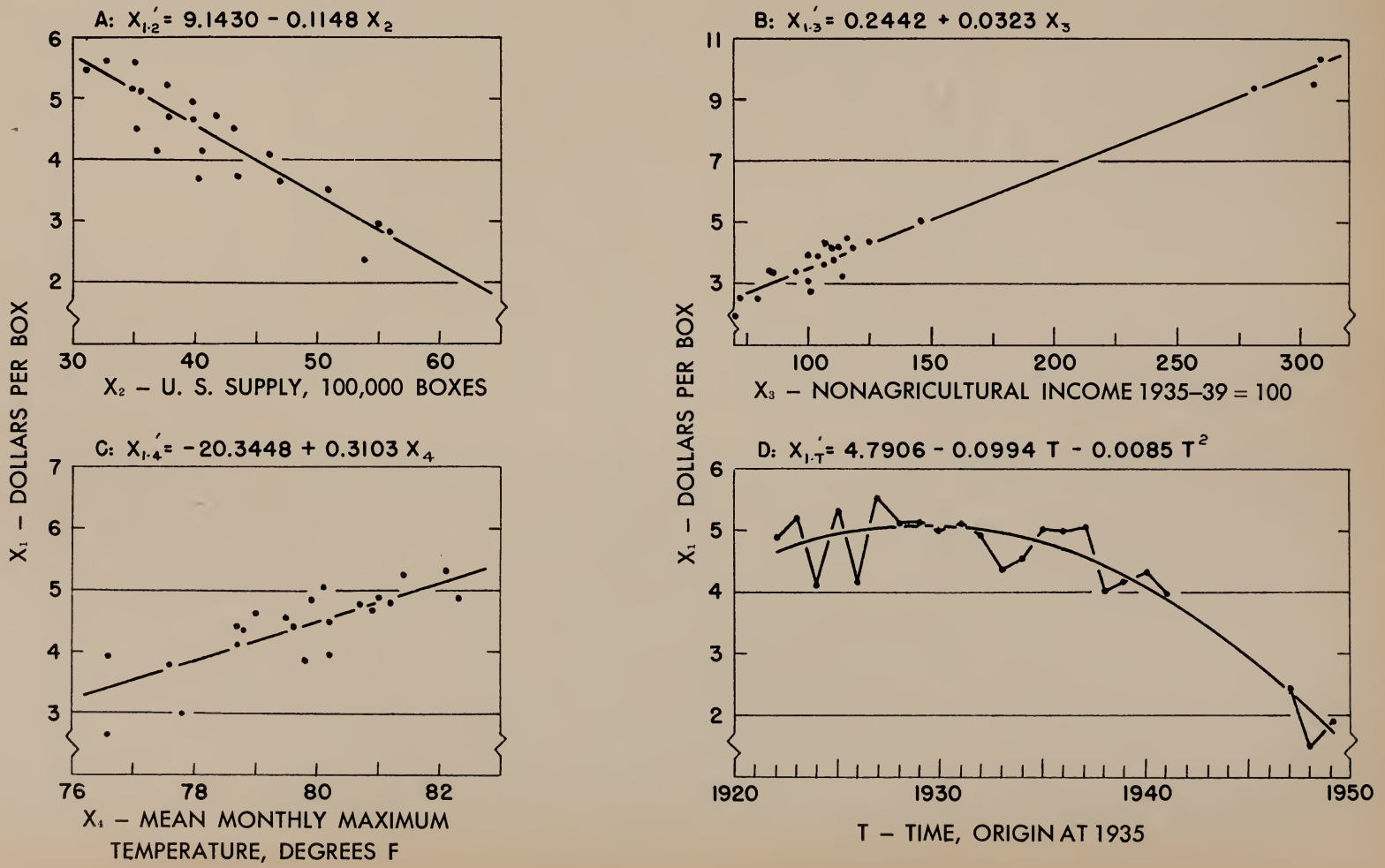
X_{2s} = United States supply of summer lemons, in units of 100,000 boxes.

X_{3s} = United States nonagricultural income payments, May–October (1935–39 = 100).

X_{4s} = Average maximum monthly temperature, May–September, in degrees Fahrenheit.

T = Time, with origin at 1935.

Figure 14. Summer Fresh Lemons; Statistical Relations Between Seasonal Average F.O.B. Prices and Major Factors Related to Them, 1922–1949.



for the demand for fresh summer lemons to have been shifting downward in recent years relative to the levels of income and temperature. Whether this tendency is only a temporary phenomenon, which will be reversed, is an important question facing the lemon industry.

The statistical evidence suggests—and consideration of the evidence in light of market behavior supports the view—that the seasonal f.o.b. prices of summer lemons for fresh consumption are in most part determined by the following factors: the United States supply of summer lemons, the level of nonagricultural income, the mean monthly maximum temperatures, and a "time" trend. Variation in those factors accounts for most of the year-to-year variation in the seasonal f.o.b. price of summer lemons. This does not mean that other factors are not influential, especially during the postwar years when developments have occurred in markets for processed lemon products. But over the period as a whole, and even in the postwar years, the four factors noted above are of major importance in the evaluation of the price-demand situation for summer lemons.

From the view of demand characteristics, the price for summer lemons tends to be inelastic for most years. Such a characteristic means that for given levels of income and temperature in a particular year for which the supply of summer lemons is associated with a price on an elastic point of the demand schedule, a smaller supply would have returned larger gross money receipts than were actually received. This characteristic of a tendency toward an inelastic demand is of great significance to the marketing of summer lemons for fresh consumption.

In view of the importance of the inelastic demand for summer lemons in most years, it is pertinent to cite other statistical evidence bearing on this point. The statistical results for summer lemons referred to above were based on the relations between the f.o.b. price and other variables. A more comprehensive approach involving interrelations between the retail, f.o.b. and on-tree levels of marketing has also been utilized. Here it suffices to indicate that such a more comprehensive analysis supports the view that the demand for summer lemons tends on the average to be inelastic. The available results, which follow, pertain to the prewar years, but are indicative of the prevailing general situation.

Summer Lemons: Elasticity of Demand with Respect to Price

(Averages for the Period, 1925–1941)

Marketing stage	Price-elasticity coefficient
Retail	−0.78
F.O.B.	−0.49
On-tree	−0.44

The results summarized in the above table are of significance not only because they also indicate inelastic demand characteristic of summer lemons, but because they are consistent with the view that the earlier the marketing stage considered, the greater is the inelasticity of demand; demand at the on-tree level is less elastic than the demand at the f.o.b. level which in turn is less elastic than the demand at the retail level. Such interrelations for the price elasticities at the various marketing stages, as noted earlier, are accounted for by the relative rigidity of marketing costs and margins.

Winter Lemons. Lemons which are marketed during the six-month period from November through April are usually referred to as winter lemons. They reach the market and are purchased and consumed during that interval which includes the winter months. This seasonal element is of significance since, as will be noted below, the temperature level

during the winter months reflects factors affecting demand for winter lemons.

Review of the available statistical evidence strongly indicates that the demand for winter lemons is inelastic at the quantities which have been marketed during the individual years since the 1921–22 winter season. The results for the separate years are summarized below.

Of the 23 years for which estimated coefficients of price-flexibility are shown in the tabulation below, the absolute value of the coefficient is greater than unity for all of the years except three. Therefore, the evidence is clear that for the quantities of winter lemons marketed in most years, the corresponding demand is inelastic; the marketing of somewhat smaller quantities would have returned larger gross revenue than was received for the quantities which were actually marketed. This demand characteristic, it may be recalled, was also generally prevalent in summer lemons, but it is even stronger in winter lemons.

Since the demand characteristics noted above are significant from the view of marketing winter lemons, it is pertinent to review the statistical analyses from which the demand characteristics are derived. As for summer lemons, a statistical equation was fitted. The f.o.b. price for winter lemons was expressed as a function of the quantity of winter lemons, nonagricultural income, an index of temperature, and a "time" trend. Before commenting on the statistical equation and its meaning, the following summary remarks on the series used may serve as a background.

The f.o.b. prices for winter lemons are seasonal average prices received by the California Fruit Growers Exchange for lemons shipped during the six-month period from November through April and sold for fresh consumption. The averages reflect all grades and sizes shipped. Beginning with the 1926–27 season, prices of lemons sold loose are reflected in the averages; for the seasons

Fresh Winter Lemons at F.O.B. Marketing Level, Annual Coefficients of Price Flexibility, 1921–22 to 1948–49 (Excluding the War Years)

Winter of	Coefficient of price-flexibility	Winter of	Coefficient of price-flexibility
1921–22	−1.46	1935–36	−1.84
1922–23	−0.81	1936–37	.....*
1923–24	−1.86	1937–38	−1.81
1924–25	−1.20	1938–39	−2.30
		1939–40	−2.69
1925–26	−1.26		
1926–27	−1.61	1940–41	−3.69
1927–28	−0.91	1941–42	−2.20
1928–29	−1.88		
1929–30	−0.92		
		war years	
1930–31	−1.65		
1931–32	−1.96		
1932–33	−1.36	1946–47	−1.75
1933–34	−1.64	1947–48	−1.42
1934–35	−3.41	1948–49	−1.30

* The 1936–37 season was omitted from the analysis because of the unusual price-quantity relation that year due to nonmaterialized expectations of frost damage to the crop.

1935–36 through 1941–42, prices of exported lemons are excluded from the averages. Hence, the price series for winter lemons was constructed in the same manner as the prices for summer lemons, except that winter lemon prices are based on shipments during the November–April period.

The trend and annual variation of f.o.b. prices for winter lemon shipments are shown in panel A of figure 15, page 38. The relatively wide swings from year to year are evident. During the prewar years, it is to be noted, there appears to have been a slight downward trend in the prices. Postwar f.o.b. prices, however, have been at a high level, with 1948–49 at an all-time peak and the two previous years near the level of the prewar high. With regard to summer lemons as well as many other products, the relatively high prices in the postwar years—high in money terms—reflect in large part the inflated general price level.

The quantity variable for winter lemons is measured by domestic shipments, which are equivalent to total industry shipments during the winter lemon season less exports during those months. The growth in the domestic shipments of winter lemons is pictured in panel B of figure 15. Along with the annual changes, there occurred an upward trend which tended to accelerate during the prewar years. The postwar level of winter lemon shipments has averaged slightly above the three years preceding the war. Thus, although the upward trend in winter lemon shipments has tended to continue, the rate of growth has not been as marked as during the 1930 decade.

The United States nonagricultural income series for the winter lemon season, November through April, is shown in panel C of figure 15. The behavior of the income series is generally similar to the income variable used in the summer lemon analysis. An upward trend occurred during the 1920's, followed by the precipitous decline after 1929–30. Then, after the low point in the winter of 1932–33, recovery developed but was interrupted by the recession in the 1937–38 season. Thereafter, recovery went on at a rapid rate up to the World War II period, during which the level of money income attained new highs. During the successive postwar years, money income continued to advance to record levels. But here, as in the price series, the money income level reflects in large part the inflated nature of the economy.

The index of temperatures used in the winter lemon analysis is based on monthly mean temperatures for the three winter months, December through February, in 32 cities, with the population in the corresponding metropolitan districts used as weights in constructing the index. The resulting index of winter temperature is shown graphically in panel D of figure 15. Annual fluctuations occur about a trend which is horizontal; that is, since 1921–22 there does not appear to have been a tendency for the temperature index to follow either a rising or declining trend. Yet, wide year-to-year changes have occurred.

In addition to the price, shipment, income and temperature variables briefly described above, the winter lemon statistical analysis also includes a "time" trend variable to reflect those influences which have systematically and persistently occurred during the years studied and which have affected the demand for winter lemons. The equation developed for winter lemons (*see footnote on page 37*) may be interpreted as describing the average relations summarized in the following terms:

A change of 100,000 boxes in the domestic shipments of winter lemons, with income, temperature, and the "time" trend held fixed at a given level, was associated on the average with a change in the opposite direction of almost 27 cents per box in the f.o.b. price of winter lemons. This relation is shown in panel A of figure 16, page 39.

A change of 10 points in the income index for the winter season, with domestic shipments, the temperature index for winter lemons, and the "time" trend held fixed at a given level, was on the average associated with a change in the same direction of about 14 cents per box in the f.o.b. price. This relation is shown in panel B of figure 16.

A change of 10 points in the temperature index, with shipments, income, and the "time" trend held fixed at a given level, was on the average associated with a change in the opposite direction of about 32 cents per box in the f.o.b. price of winter lemons. This relation is shown in panel C of figure 16.

A change of one year in the "time" trend variable, with shipments, income, and temperature held fixed at a given level, was on the average associated with a change in the same direction of about 12 cents per box in the f.o.b. price of winter lemons. This relation reflects the tendency, which has existed during the period under review, for the demand for winter lemons to increase as shown in panel D of figure 16.

The net relations between the f.o.b. price for winter lemons and the other variables in the analyses are shown in figure 16, page 39. This shows, graphically, the relations as summarized above in the interpretation of the statistical equation.* The solid lines in each of the panels of figure 16 reflect the net statistical relation between the two indicated variables, holding the other variables constant. The differences between the actual price and that estimated by the statistical equation for each year are plotted as deviations from the net relation line in each of the panels.

The equations which have been presented and reviewed are sometimes termed "statistical demand equations." They are descriptive, in an average sense, of the relations which have been generally prevalent between the price and the other variables in the equation. The net relation between price and quantity, holding the other factors constant, is sometimes referred to as a statistical demand curve or schedule. In fact, some of the properties bear a similarity to the economists' theoretical demand curve, yet there are important differences.

The economist's theoretical demand curve expresses the functional net relation between price and quantity, all other factors held constant, and pertains to a time interval in which consumers' tastes, preferences, money income and the prices of other goods are fixed. Such a strict and conceptual ideal is not attained by the statistical demand equation. Consumers' tastes and preferences and money income—as well as prices of all other goods, in fact—were not unchanging during the period studied. The statistical analyses adjusted for such changes, but only imperfectly. Also the statistical equation is descriptive in an approximate sense of the average situation reflecting both demand and supply over the entire period, where in fact the situation in supply and demand varied from season to season. Hence, the statistically derived relations between price and quantity cannot be presumed to be a theoretical de-

* The statistical equation developed for winter lemons, covering the period 1921–22 through 1948–49, but omitting 1936–37 and 1942–43 through 1945–46, may be summarized as follows:

$$X_{1w} = 10.3858 - 0.2679\,X_{2w} + 0.0144\,X_{3w} - 0.0321\,X_{4w} + 0.1185T$$
$$\qquad\qquad (6.319) \qquad (7.424) \qquad (2.217) \qquad (3.814)$$

$\bar{R} = 0.915$; n = 23; and figures in parentheses are t-ratios. Equation was fitted to data in table 3, page 71. Also see table 8, page 76.

X_{1w} = F.o.b. price of winter lemons for fresh consumption, in dollars per box.

X_{2w} = Domestic shipments for fresh consumption, November–April, in units of 100,000 boxes.

X_{3w} = Index of United States nonagricultural income, November–April, 1935–1939 = 100.

X_{4w} = Index of temperatures (December, January, February), 1931–32 = 100.

T = Time, origin at 1934–35.

Figure 15. Winter Fresh Lemons; Seasonal Average F.O.B. Prices and Factors Related to Them, 1922–1949.

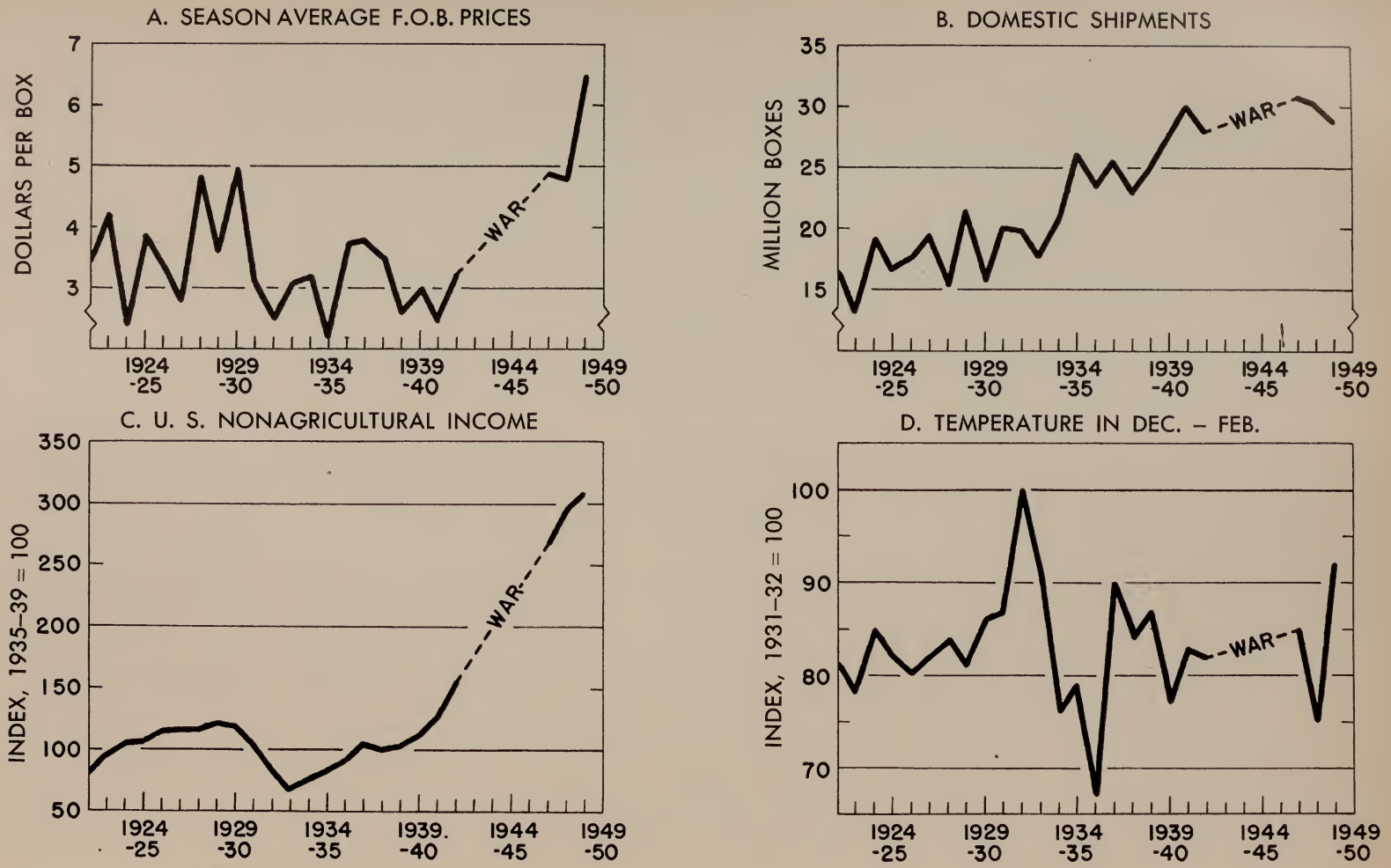
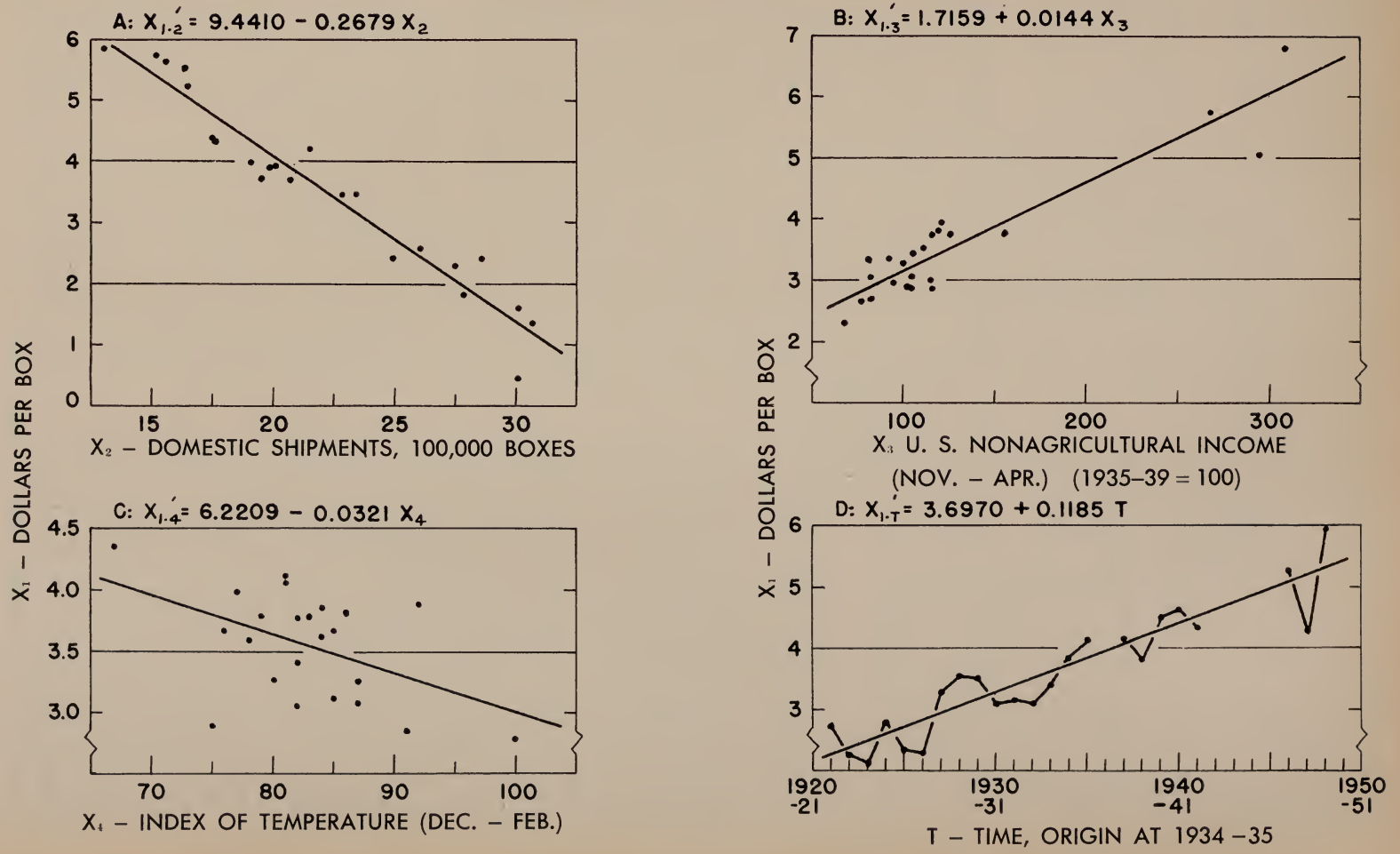


Figure 16. Winter Fresh Lemons; Statistical Relations Between Seasonal Average F.O.B. Prices and Major Factors Related to Them, 1922–23 to 1948–49.



mand curve. But one can presume that the statistical equation reflects the demand side of the market and to that extent is helpful in the analysis of market behavior. It is on such grounds that one may interpret the use of the statistical demand equations for lemons in the review and analysis of marketing plans and programs.

Comparison of Summer and Winter Demand. We are now at the point where we may profitably compare the demand characteristics for summer and winter lemons, respectively.

It may be noted that the demands for both summer and winter lemons tend to be inelastic, with the inelasticity characteristic more consistent and more marked for winter lemons than for summer lemons.

Next may be noted that the demands for both summer and winter lemons are responsive to changes in the money income level; as income goes up, demand increases; and as income declines, demand decreases. The response to income, however, appears to be more pronounced for summer lemons than for winter lemons.

It may then be seen that the demands for both summer and winter lemons are responsive to changes in temperature, but in opposite ways. For summer lemons, as the temperature index advances, the demand for summer lemons also advances; as the summer temperature index declines, the demand for summer lemons also declines. But for winter lemons, when the temperature index advances, the demand for winter lemons declines, and when the temperature index declines, the demand for winter lemons increases.

These relations between temperature and demand for fresh lemons correspond with trade observations and may be rationalized as follows: During the winter months, low temperatures are associated with the spread of colds and other respiratory virus infections which are combated by many people with the use of fresh lemons. During the summer months, high temperatures encourage the consumption of cold beverages, a popular one being fresh lemonade. Hence, extreme weather conditions, in both winter and summer, tend to react favorably on the demand for lemons.

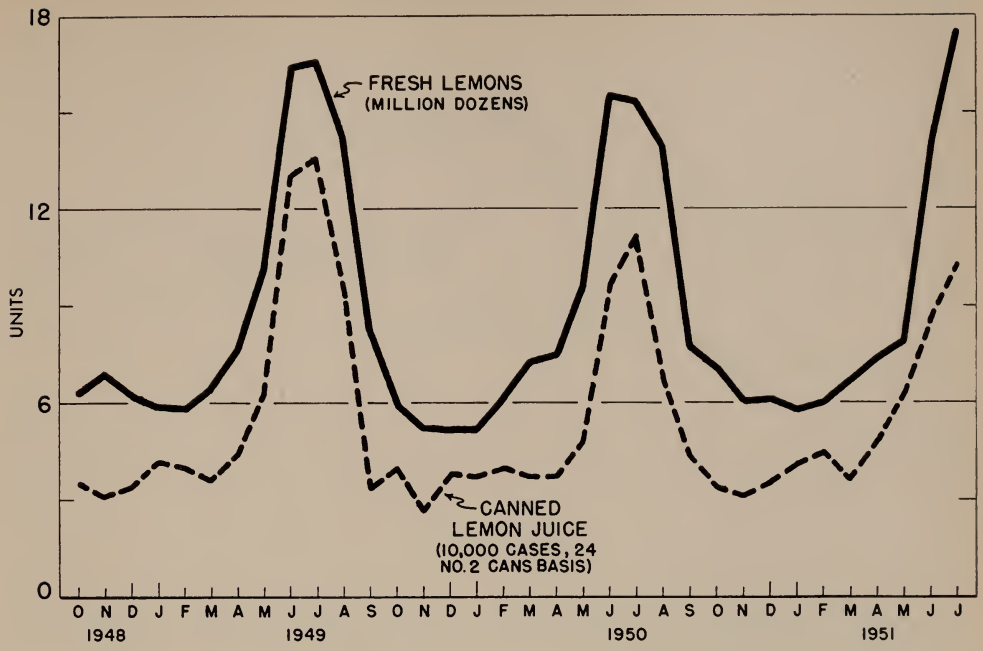
Again, with respect to winter lemons, there has prevailed a strong tendency for the demand to increase. Some of the evidence suggests, though, that the demand for summer lemons in recent years has tended to level out, and may actually border on a decreasing phase.

Related Demands. In consideration of the behavior of the trend in demand for fresh lemons, especially for the near recent period and the future trend, attention must be directed to the market situation in edible lemon products. The output and consumer purchase of canned lemon juice, for example, has increased substantially in relative terms above prewar years. More recently, there has been a marked growth in the output and consumer acceptance of frozen citrus concentrates as well as lemon preparations for making lemon-flavored drinks, fillings and similar uses in which fresh lemons for long have held first priority. Hence, a significant question pertains to the demand relations between fresh lemons and lemon products processed for fresh consumption.

Due in large part to the relatively recent developments in the edible lemon products markets, adequate statistical data and marketing information are not available for making a formal statistical analysis of demand interrelations. We can, however, review the recent trends in one of the lemon products, canned lemon juice, and attempt an introductory analysis of its demand relation to fresh lemons.

Estimates of monthly consumer purchases are available on a national basis for both fresh lemons and canned lemon juice, natural strength, beginning in October, 1948. Those data are shown in figure 17, page 41. It shows that for both

Figure 17. Fresh Lemons and Canned Lemon Juice; Consumer Purchases, by Months, from October 1948.



the fresh lemons and canned lemon juice,* there is a strong seasonal movement; retail sales rise sharply in the summer months and tend to reach a peak in July. In view of the statistical evidence cited above—that the demand for fresh summer lemons is directly related to the level of summer temperature—one is tempted to infer that the demand for canned lemon juice is also directly related to the level of summer temperature.

The estimated national average retail prices for fresh lemons and canned lemon juice are shown graphically in figure 18, page 42. Review of the fresh lemon monthly price series indicates a tendency for a seasonal upward rise in the months which usually have extreme cold and extreme warm weather. But when the monthly prices of canned lemon juice are reviewed, no pronounced seasonality is evident. It is clear that the variability from month to month is much less strong in the retail prices of canned lemon juice than in those of fresh lemons. Such comparative price behavior may be accounted for by the summer and winter seasonal cycles of fresh lemon prices superimposed upon the nonperishable characteristic of canned lemon juice. The relative perishability of fresh lemons, coupled with seasonality in demand, is a factor which is related to the seasonal movement in their prices, and this characteristic is usual for perishable commodities in general which have seasonal demand. Hence, the marked seasonality in sales and consumption of canned lemon juice is not reflected by a noticeable seasonality in prices primarily because of the nonperishability of canned lemon juice.

A relevant question is that in view of the similarity of the seasonal patterns of retail sales of fresh lemons and canned lemon juice, with their retail price patterns, what are the consumer demand relations between fresh lemons and canned lemon juice? In other terms, to what extent, if at all, are the two competitive in

* The phrase "canned lemon juice" refers to lemon juice packaged in both tin and glass.

Figure 18. Fresh Lemons and Canned Lemon Juice; Retail Prices, by Months, from October 1948.

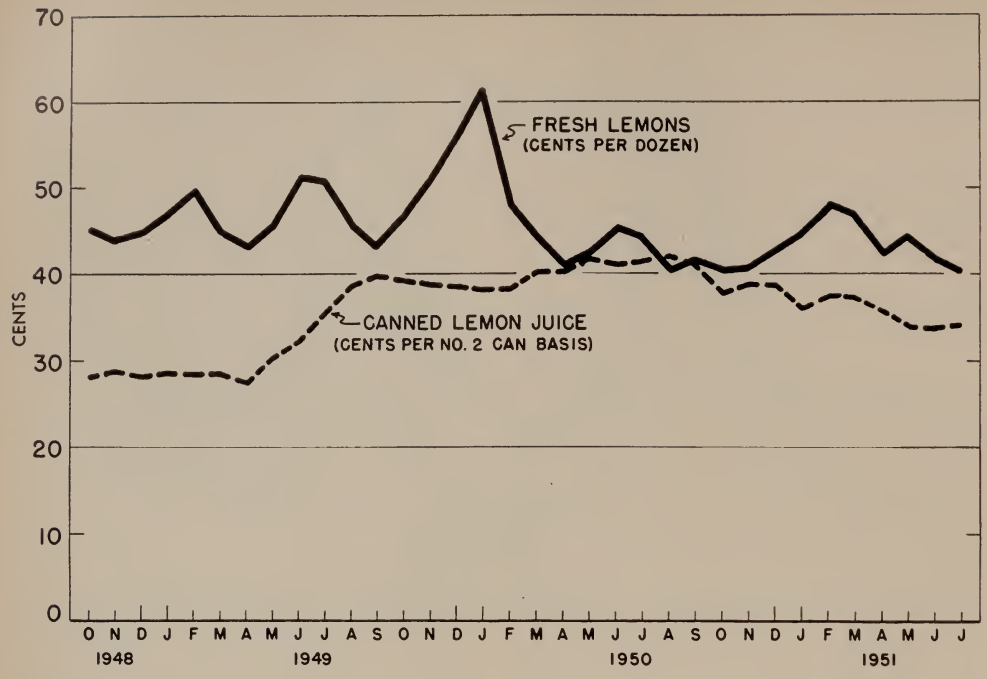
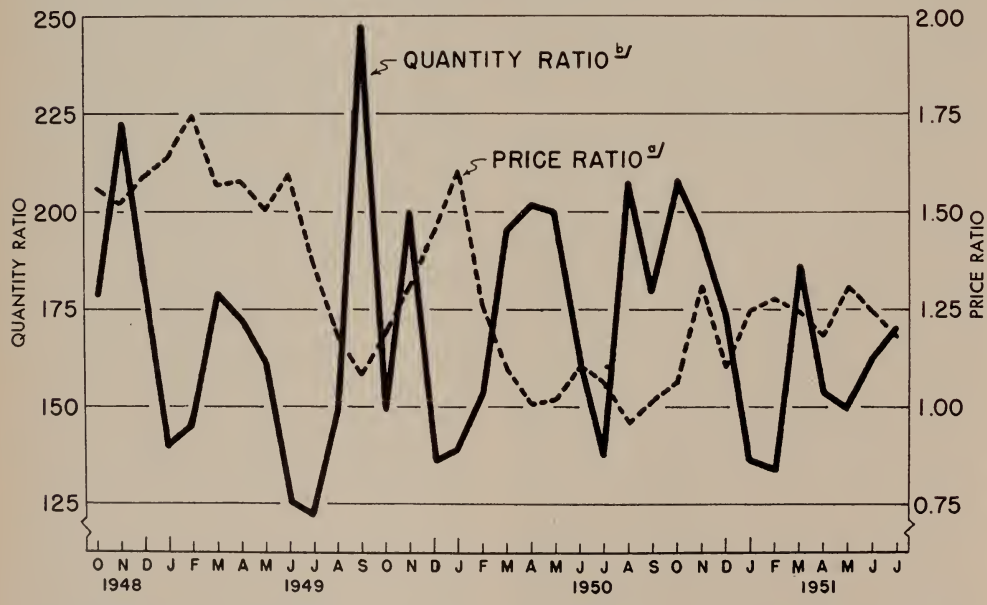


Figure 19. Price Ratios and Quantity Ratios for Fresh Lemons and Canned Lemon Juice, by Months, from October 1948.



a) Retail prices of fresh lemons (in cents per dozen) divided by retail prices of canned lemon juice (in cents per No. 2 can).

b) Consumer purchases of fresh lemons (in thousands of dozens) divided by consumer purchases of canned lemon juice (thousands of cases of 24 No. 2 cans).

consumption from the view of the consumer? Is canned lemon juice considered and used as a substitute for fresh lemons? With the relatively meager data available bearing on this point, only an indication, at best, may be obtained at present.

An introductory analysis may be cited which gives preliminary evidence concerning the competition in consumption of fresh lemons and canned lemon juice. This analysis considers the relative variations in the quantity and price ratios and proceeds on the premise that if the price ratios are relatively more variable than the quantity ratios, the two products are complementary in consumption, or increased use of one goes along with increased use of the other. If the quantity ratios fluctuate relatively more widely than the price ratios, then the two products are substitutes or competitive.

Figure 19, page 42, shows monthly quantity and price ratios, respectively, for the period beginning with October, 1948. The quantity ratios reflect the sales of fresh lemons in a given month divided by the sales of canned lemon juice in the same month. The price ratios reflect the price of fresh lemons in a given month divided by the price of canned lemon juice in the same month. The quantity ratios have tended to follow a very slight upward trend during the first part of the period under consideration, although the trend is not sufficiently marked to be significant. The price ratios, however, have tended to follow a distinct downward trend through the middle of 1950, followed by a rising trend. The situation was first one where the retail price of canned lemon juice definitely tended to rise relative to the retail price of fresh lemons, then the situation was reversed. Reference back to figure 18, page 42, clarifies what has occurred. There it may be noted that the seasonal rises and declines in fresh lemon prices are superimposed upon a trend which was slightly rising during the first half of the period, and then fell back to a level slightly under that of the beginning of the period. The canned lemon juice price was highly stable from October, 1948, through April, 1949, then rose steadily for the next five months and reached a level which was maintained for another six months. Thereafter, a slight rise in the price developed only to be followed by a subsequent decline toward the end of the period. The net result was that the spread between the prices of canned lemon juice and fresh lemons narrowed sharply during the first half of the period, and then tended to widen again but not to the earlier extent.

Before measuring the relative fluctuations in the price and quantity ratios, the price ratios were adjusted so as to eliminate their trend noted above. Then, coefficients or measures of relative variation were computed as follows:

Period	Coefficients of variation	
	Quantity ratios	Price ratios
	(Per cent)	
Winter lemons (Nov.–April)	16	9
Summer lemons (May–Oct.)	20	9
Crop year (Nov.–Oct.)	17	10

Since the quantity ratios vary relatively more than do the price ratios, the conjecture may be made that canned lemon juice and fresh lemons tend to be competitive in consumption, and one is substituted for the other, depending on their price relations.* Such substitution,

* A similar conclusion follows from another test; the regression of the price ratios on the quantity ratios is negative, indicating that as the price of fresh lemons decreases relative to that of canned lemon juice, the quantity of fresh lemons purchased tends to increase relative to that of canned lemon juice.

of course, is not practiced by all consumers, nor for all uses of lemons. But the results of preliminary analysis support the view that a noticeable degree of substitution does exist.

The general tendency concerning the behavior of fresh lemon prices in relation to canned lemon juice prices, associated with the behavior of fresh lemon sales in relation to canned lemon juice sales, serves as some basis for considering the demand relations between fresh lemons and canned lemon juice. The statistical evidence is not markedly pronounced, but it is such that one may conjecture that fresh lemons and canned lemon juice are competitive from the viewpoint of the consumer, at least for some uses. The consumer household, it appears, has some tendency to substitute canned lemon juice for fresh lemons when their relative prices make such substitution advantageous. Such substitution need not be complete in the sense that it occurs in all uses or in the sense that it is practiced by all consumers. Yet, the tendency toward substitution, depending upon the relative prices, is sufficiently strong so that it may be inferred from the data on retail sales and prices.

It is pertinent to note here that the statistical analyses summarized above on the competitive relations between consumer demands for fresh lemons and canned lemon juice are only preliminary. Data on retail sales and prices for a longer period are necessary to establish the validity of the findings on a firmer base. With such more adequate data available, more refined and sensitive analyses and tests could be applied.

It is also pertinent to note that market expansion is now developing in other edible processed lemon products which may have a considerable degree of competition in consumption with fresh lemons; examples include concentrates for lemonade. The available data on these new products are much too meager to use even in a preliminary analysis, the findings of which would merit some attention; yet, market observation and trade opinion in some quarters suggest that frozen lemonade concentrate is definitely competitive with fresh lemons. Such a view seems plausible and merits close examination as adequate statistical and market information is accumulated.

There are grounds for believing, in view of the available evidence, that with respect to demand interrelations between fresh lemons and processed edible lemon products—such as canned juice and frozen lemonade concentrate—the lemon industry is in a period of transition. Most of the history of the lemon industry in this country reflects a period when the lemon crop utilized was channeled into the fresh shipping markets, or into processed products which did not directly compete in consumption with fresh lemons. During the past several years, the processed edible lemon products market has attained more significance. The lemon crop thus utilized is now channeled into canned juice, frozen lemonade concentrate, and processed lemon products which do compete more or less significantly with fresh lemons in consumption. Yet, the newer outlets have not yet established their relative positions so that the proportions of the lemon crop utilized in the various outlets is relatively constant. The lemon industry, then, is faced with a transition of indefinite duration. The length and extent of the transition apparently will be influenced by the degree to which the newer outlets for lemons will expand in relation to the over-all market for lemons and lemon products. Such relative expansion, in turn, will be influenced by the price relations between fresh lemons and the major lemon processed products.

It may be noted that the competitive situation between fresh lemons and processed lemon products is of most significance with respect to potential developments. Fresh lemon sales still exceed by far those of the processed lemon

products. Yet, price relations which encourage the shifting from purchases of fresh lemons to processed products could result in a situation where a significant proportion of the crop would go to the processed outlets.

Summary. The evidence is reasonably clear that the demand for lemons, both summer and winter, tends to be inelastic at the volumes which have been marketed in past years. The demand inelasticity appears to be more pronounced in winter lemons than in summer lemons. Hence, from the short-run view of the lemon industry, decreased volume of marketings of fresh lemons can be expected to yield increased gross money returns, although not necessarily increased net returns. A policy of indiscriminate marketing restrictions of fresh lemons need not have beneficial industry results from the long view because of demand relations between fresh lemons and processed edible lemon products. The continuous practice of fresh lemon volume restriction year after year encourages consumers to shift from the use of fresh lemons to processed lemon products. Such shifting tends to decrease the demand for fresh lemons. In other terms, from the long-run view, or over a period of years, the availability of competitive lemon products sets a ceiling on the marketing restrictions on fresh lemons which may be profitable in money returns to the industry. This aspect of marketing fresh lemons has developed into a significant problem only recently, since canned lemon juice and frozen lemonade concentrate have reached important market development.

The demands for both summer and winter lemons are influenced by the levels of income and temperature. As the income level increases, the demand for summer and winter lemons increases; as national income decreases, the demand for lemons decreases. As the temperature level increases, the demand for summer lemons increases, but the demand for winter lemons decreases; as the temperature level decreases, the demand for summer lemons decreases but the demand for winter lemons increases.

Both summer and winter lemons, through the years, have experienced a shift in demand reflecting a set of influences which have smoothly and persistently operated. Consumer education and advertising, as well as improved merchandising and marketing, may be reflected by the upward shift in demand. This upward shift in demand is characteristic of the entire period studied for winter lemons, but for summer lemons, the upward shift in demand has in recent years tapered off and may be on the threshold of entering a downward phase.

There is some evidence which suggests that canned lemon juice is competitive in consumption with fresh lemons to some extent. The market experience with frozen lemonade concentrate is too new and the available data are too meager to provide a statistical base for making inferences concerning consumption competition between that processed lemon product and fresh lemons. Market observation suggests that purchases of the frozen lemonade concentrate may in part be competitive with fresh lemons, and in part reflect new demands. A similar situation appears to exist with respect to canned lemon juice. Hence, the expansion of such products, although competitive in some degree with fresh lemons, may likely result in a net increase in the total demand and use of lemons and lemon products.

Fresh lemon prices are affected by the volume of fresh lemons sold and purchased, the income level, temperature, and a "time" trend—and, we may add, the relative prices of competitive lemon products. The lemon industry has no control over the level of national income nor over the temperature. But the industry is in a position to exert influence on the volume of fresh lemons marketed through the Lemon Administrative Committee.

Educational and promotional activities can influence the "time" trend as have advertising campaigns in the past. In order to maintain and expand the demand for fresh lemons, the industry can continue its promotional activities. Equally or more significant problems which merit increased industry attention, though, are the policies and programs relating to the shipments of lemons to the fresh and processed outlets, in light of the recent developments in the processed edible lemon products markets. The next section of this study, therefore, will include some further considerations of the major marketing problems which face the lemon industry. The materials discussed so far provide necessary background.

III. DISTRIBUTION OF THE LEMON CROP AMONG FRESH AND PROCESSED OUTLETS

The two preceding sections have set forth some pertinent aspects of the lemon industry, as background for consideration of current and prospective problems. The first section highlighted the major developments which have occurred in the lemon industry, and the second reviewed the significant characteristics of demand for fresh lemons and the major factors affecting their seasonal average prices.

The postwar level of lemon production has generally been above that of the prewar years. Since 1945–46, however, annual production has followed a declining trend. Such decline has in part reflected a decreased yield per bearing acre, and in part resulted from a noticeable decrease in bearing acreage. The proportion of the lemon crop going into processed products has averaged, in recent years, a lower percentage than that which prevailed during the early years of the war and those years immediately preceding it. But the proportion of the crop processed is now much higher than the percentages up through the middle 1930's. The volume of lemons moved into fresh consumption has varied, from year to year, much less than did production. Hence, through the years, there has been a close correspondence between the annual changes in the volume of lemons moved into processed outlets and total supply available for distribution between the fresh and processed outlets.

The relative stability, from year to year, in the volume of lemons moved into fresh consumption, and the corresponding instability in the volume moved into processed lemon products, stems from a combination of two influences. First is the fact that the volume of the lemon crop harvested annually has varied fairly widely, especially during the war and postwar years. Superimposed upon that situation is the second influence which is related to the marketings of fresh lemons. The operation of a fresh lemon volume proration marketing program has tended to stabilize, in relative terms, the volume of annual supplies moved into fresh consumption.

Factors Affecting the Marketing of Fresh Lemons. The distribution of the lemon crop among alternative uses, such as the volume going into fresh consumption compared with the volume going into processed products, involves a series of questions which are related to the major marketing problems facing the lemon industry. Such questions include the nature of the demand characteristics of fresh lemons and processed lemon products, and their relative prices and volumes. For that reason, the preceding section reviewed the demand characteristics of fresh lemons. It was noted there that available statistical evidence indicates that the demand for fresh lemons, both summer and winter, tends to be inelastic within the range of marketings which have been experienced by the in-

dustry; hence, somewhat reduced volumes of fresh lemon marketings may be expected to be associated with increased gross money returns from fresh lemons. It is this relationship which is essential in considering the fresh lemon marketing program mentioned below. Before inquiring further into that question, however, we may note that available statistical evidence also suggests that the major determinants of annual fresh lemon prices, at the f.o.b. level, include the volume of fresh lemons marketed, the level of money income, the level of seasonal temperature, and a "time trend" which reflects changes in consumer preferences and marketing practices. Hence, lemon prices and returns may be considered as being affected by various types of influences, some of which are in part controllable by the industry and others which are independent of decisions made by, or practices of, the lemon industry.

The factors of national income and temperature are external influences in the sense that their levels are given to the industry which must adjust to them. The "time trend" is in some part subject to industry influence; and the volume of fresh lemon marketings is, within wide limits, subject to industry determination. The size of the lemon crop, in a given season or even over a short period, is independent of industry action, but the industry can affect the distribution of the crop among alternative outlets. It is clear, then, that a crucial question pertains to the types of distribution among alternative outlets the industry determines or encourages. The significance of such a question lies in the fact that different utilization distributions result in differing levels of money returns to the industry.

Decrease in Acreage. During the past half-decade, lemon-bearing acreage has tended to go downward, and even total acreage has decreased for the period as a whole. This may be only a temporary situation, but it does suggest the existence of alternative uses of the land and resources in activities other than lemon production. Such alternatives may be of various types, such as a shifting to the production of other agricultural products, or orchard removals and land subdivision for real-estate development. Such shifts away from lemon production are not necessarily evidence that lemons do not yield net profits to the growers; such shifts may occur even when the net profits from lemon production seem favorable to some individuals. The essential point is the level of net profits resulting from using the land and resources of a given area in producing lemons as compared with using the same land and resources in other lines of economic activity. Hence, in order to maintain lemon acreage and production, the crops must be produced and marketed so that their net income can compete with that income which could, in the opinion of the owners, be derived by using the resources in other ways. The distribution of the lemon crop among alternative outlets enters here because the distribution affects returns and thereby influences decisions as to whether the acreage and other production resources are retained in the lemon industry or shifted to other uses.

Distribution Patterns. The lemon crop may be distributed among various outlets according to many different patterns. There is the obvious distribution among the two major markets, fresh and processed. Within the fresh market itself, there is a limited distribution over time between the summer and winter marketing seasons; such can be done by lengthening or shortening the storage periods on the tree or in curing after picking. Furthermore, there is the distribution of the total fresh movement among domestic and export markets, and between various market areas within the domestic market. Also, in the processed outlet itself, there are many possible distributions among the various processed products. Here we shall primarily be concerned with the distribution of the crop between the total

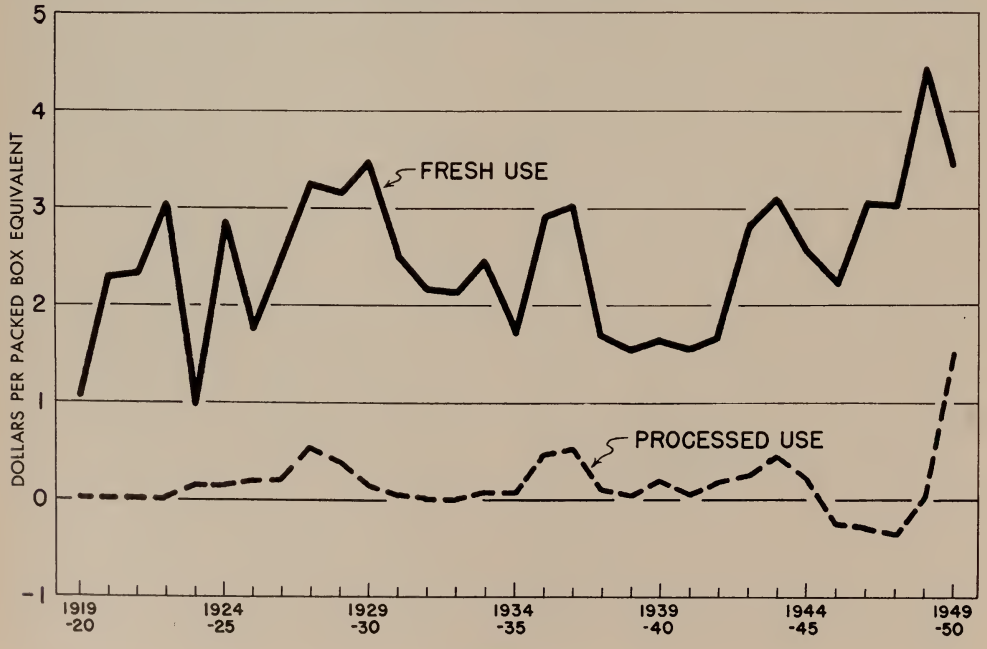
fresh market and the total products market.

We have previously shown that the volume of lemons which has been channeled to the fresh outlet has varied considerably less, from year to year, than the volume which has been channeled to the processed outlet. This has resulted, of course, from the fact that the crop has varied, while the volume moved into fresh channels has been held relatively stable; thus, the residual production, or the total production less the supply moved to the fresh outlet, has tended to fluctuate along with production. Hence, there is the question of why the volume moved to the fresh market has been relatively stable.

In the previous section evidence was presented which suggests that the aggregate demand for fresh lemons tends to be inelastic in the neighborhood of the quantities usually marketed. Hence, by marketing as fresh lemons a quantity less than the volume usually produced, the gross money revenue may be increased. This situation has in recent years existed in the face of annual production fluctuating in the range of 12 to 14 million boxes, with 7.5 to 9.5 million boxes marketed fresh. The reduced volume sold fresh has resulted in higher prices per box, as well as increased gross money returns, than would have prevailed otherwise. The residual supply of lemons—those not sold for fresh use—have, in the main, been moved into the processed lemon products market.

Differential Returns—Fresh and Processed Lemons. Associated with the relative volumes sold for fresh use and processing, noted earlier, there have been differential returns to lemon growers. Figure 20, below, shows computed average "on-tree" returns for lemons over the years since 1919–20. Two striking features are evident from the figure. First, it may be noted that the returns per box for fresh lemons have consistently been higher by a substantial amount than the returns per box from lemons sold for processing. Secondly, it may be noted that the per-box returns from lemons sold for processing have been at very low level and, in some years, have even been nega-

Figure 20. On-Tree Returns from California Lemons, Fresh Use and Processed, from 1919–20.



tive. Such price relations may result from a number of different marketing policies we shall later consider. But first it is pertinent to consider further certain aspects of marketing as it pertains to fresh lemons.

The Fresh Shipping Lemon Prorate. The federal Agricultural Marketing Agreement Act of 1937 provided a mechanism whereby the lemon industry could put into effect compulsory industry programs intended to regulate the volume of lemons sold for fresh use and thereby influence their prices, but not so they would exceed their legislatively defined "parity" level. Since June 1, 1941, California lemons for fresh use have been marketed under a federal program of volume proration, in accordance with the provisions of the 1937 Act. The type of program instituted regulates the volume of fresh fruit to be shipped over specified periods of time. In addition to, or in the process of, influencing prices and returns, the program has as an objective the promotion of "orderly marketing" to reduce the occurrence of periodic gluts and scarcities in the supply flow of fresh lemon shipments during the season.

A program may be effectuated after hearings at which the proponents and opponents of the proposed program may state their views, and after a vote has been taken of growers and handlers. If at least three-fourths of the growers by number (or at least two-thirds of the growers by volume) and handlers controlling at least 80 per cent of the volume of the lemons shipped vote in favor of the proposed program, it stands as approved as an order with a marketing agreement and is compulsory for the entire industry. In certain cases, an order may be approved without consent of the handlers.

The agreement itself does not effectuate the program. To activate a federal marketing agreement program, a marketing order must be issued by the Secretary of Agriculture. On April 5, 1941, the Secretary of Agriculture issued an order, under the Agricultural Marketing Agreement Act of 1937, providing for the regulation of the handling of fresh shipments of lemons grown in California and Arizona. The first regulation of shipments started with the week of June 1, 1941, and the program has continued to operate since that date. The original order has been amended on several occasions, but the basic intent and objectives remain the same.

The fresh lemon order, commonly known as the "lemon prorate," is administered by a committee of six members, one member not being directly associated with the industry and considered as a representative of the general public. The administrative committee operates through a hired manager who carries out the committee's decision. The committee generally meets weekly, and with information furnished by its field representatives estimates the quantity of lemons available for fresh shipment. Such volume estimate, together with credit counts (credit for estimated life, under commercial storage conditions, of lemons shipped to products channels currently) constitutes the prorate basis. The percentage of the total quantity of lemons and advance credits equals 100, and each handler's individual total with respect to the industry total determines his percentage of the total prorate for the next week.

The order is flexible in that it allows for over- and undershipments, loans and transfers of allotments, and adjustment of prorates on short notice if deemed justified by changing market conditions. The committee may suspend the prorate at any time if it believes that proration is not needed because of a scarcity of lemons available for shipment.

A significant aspect of the lemon prorate is that the prices of fresh lemons are influenced by regulating the flow of fresh lemon shipments. Although movement into products channels is considered, the prime attention is directed to the flow of fresh market shipments, their prices and

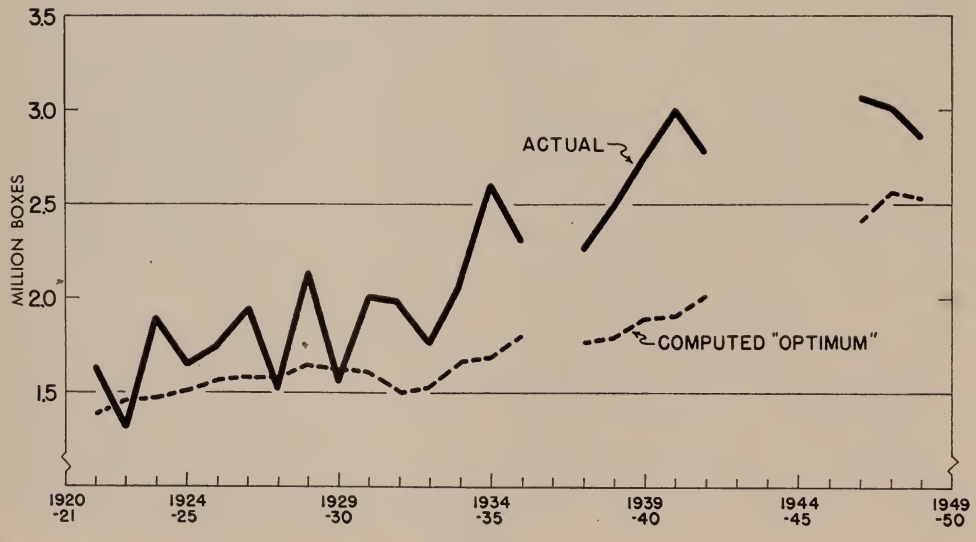
returns; prices and returns from lemon products are considered only indirectly. In other terms, the lemon prorate does not directly grapple with the problem of allocating the total seasonal supply of lemons between the fresh and processed markets so as to attain clearly specified objectives of price and returns from the entire crop. The lemon prorate directs its primary attention to influencing the time distribution of fresh shipments, and the utilization distribution is secondary.

Although the federal fresh lemon prorate has operated only since April, 1941, prior to that date industry attention was to some extent directed to the temporal distribution of fresh lemons, as well as the distribution of the lemon crop among the fresh and processed markets. Shipments to the fresh market were made so as to attain "satisfactory" prices and returns; the rest of the crop was channeled to the products outlets. Also, there were lemons which, while of satisfactory internal quality, were not readily salable in the fresh fruit market. Oversized or undersized lemons, scarred or misshapen lemons and other lemons having an objectionable external appearance could not profitably be moved into the fresh market for which there were ample supplies of physically satisfactory fruit. But through all of this period, before and after the initiation of the fresh lemon prorate, the lemon industry relied in most part on the fresh market—worked for raising prices of, and returns from, the fresh lemon market. The industry viewed the lemon products utilization mainly as a by-product or salvage operation. Lemons that were physically acceptable in the fresh market were processed because their fresh shipment was not considered economically profitable to growers and shippers. Hence, it is of interest to compare the lemon supplies made available for the fresh market with corresponding volumes which would have yielded maximum gross money returns from fresh lemons.

Actual and Derived Volumes of Fresh Lemons Marketed. We now consider the following questions: (1) Given the estimated demand conditions which have prevailed in each year, what volume of fresh lemons would have yielded maximum gross money returns at the f.o.b. level and (2) how does that volume compare with the actual volume for the respective year?

Here we may again use, to good ad-

Figure 21. Winter Fresh Lemons; Shipments, Actual and Computed "Optimum" at F.O.B. Level, from 1921–22.



vantage, the statistical demand equations developed in Section II. There, we considered equations expressing the f.o.b. prices of winter and summer lemons, respectively, as functions of specified variables including the quantity of lemons, income, temperature and "time trend." With the income, temperature and time trend values given for each of the years, we may derive the statistically estimated net relation between the price and quantity prevailing in the specified years, and thus have approximations to the fresh lemon demand situation in the respective years. Such was done for winter and summer lemons, respectively.

An indication of the answer to the first question may be obtained by using the annual equations referred to in the preceding paragraph and deriving the quantity associated with maximum gross money returns at the f.o.b. level.* An indication to the second question may be obtained by noting differences between the actual quantities and the derived quantities associated with maximum returns. In figure 21, page 50, are shown, for winter lemons, the actual quantities and the corresponding derived quantities which maximize gross money returns for the years beginning with 1921–22.† Similar results for summer lemons are shown in figure 22, on page 52.

Figure 21 suggests that in the period considered, except for three of the years, the gross revenue-maximizing quantities of winter lemons are less than corresponding actual quantities. This result is in line with the price-flexibility characteristics noted, for the various years, in Section II. In other terms, for each of the years except three, larger money gross returns from winter fresh shipments could have been obtained by shipping a smaller quantity than was actually shipped. The "excess" quantity shipped of winter lemons each year is represented by the vertical difference between the line of actual shipments and the line of derived shipments. It may be noted that except for the early years in the period, the trends are roughly similar for the actual and derived winter quantities.

The actual and derived quantities associated with gross money returns (f.o.b. level) for summer lemons are charted in figure 22. During the first decade of the period covered, both quantity series fluctuate roughly about the same level, with the derived quantities in some years exceeding the actual ones. After 1934, however, the actual quantities rose substantially, whereas the derived ones continued fluctuating around their previous level. During the postwar years shown, both series varied within comparable ranges; although in 1948 and 1949, the derived quantities exceeded the actual ones. Hence, for those two years, it appears that the actual quantity of summer lemons was undershipped while the quantity of winter lemons was overshipped, in terms of deriving maximum gross money returns, at the f.o.b. level, from the summer and winter supplies, respectively. The situation in 1949 was created by the severe freeze resulting in a shortage of supply.

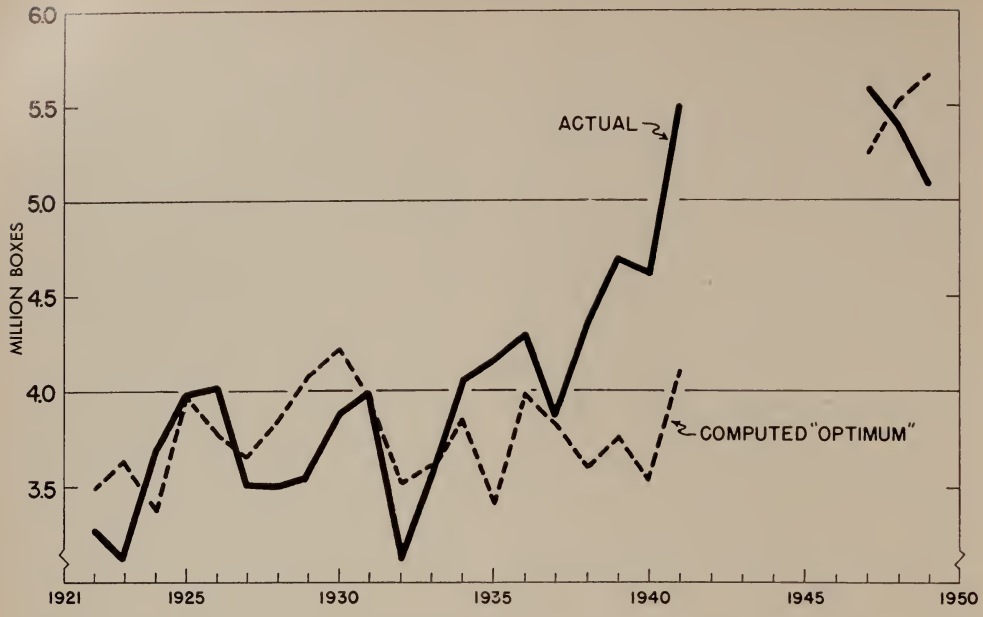
The preceding comparative analysis of actual and derived quantities of fresh lemons, winter and summer separately,

* The quantity may be indicated as follows: where p and q, respectively, are price and quantity, and $p = a - bq$ is the estimated demand relation prevailing in a given year; $q = a/2b$.

† The computed "optimum" shipments of winter lemons were determined by applying to the equation for winter lemons on page 37 the annual values of the respective independent variables, except for X_{2w}, and deriving the annual net statistical demand relations between X_{1w} and X_{2w}; from such equations, the "optimum" shipments were derived as indicated in the preceding footnote. The results for individual years are in table 4, page 72.

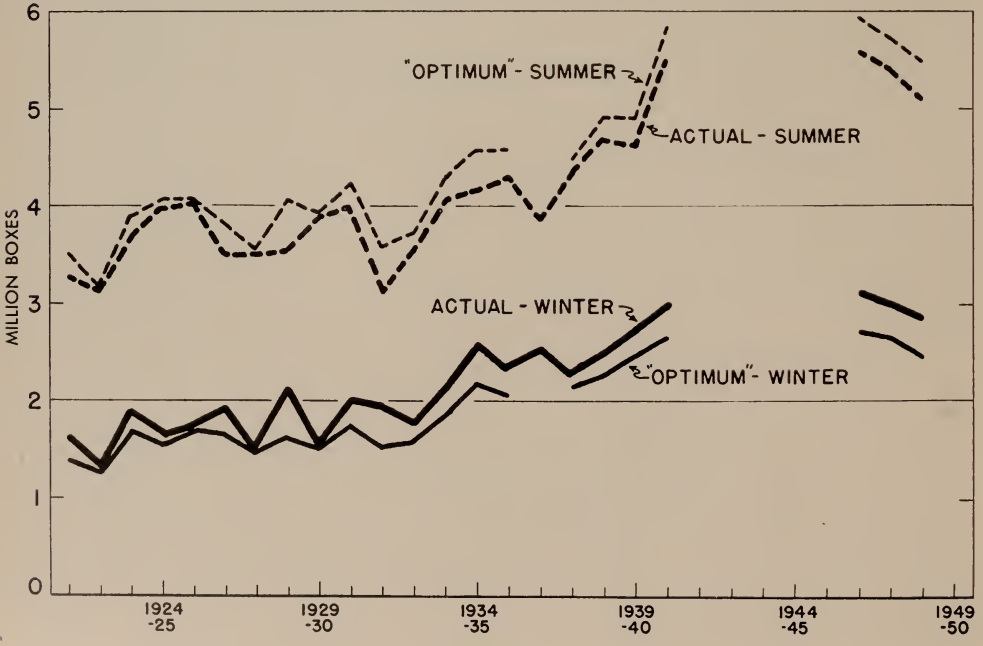
The computed "optimum" quantity of summer lemons each year was determined in a similar manner, except the equation for summer lemons on page 32 was used to derive the annual net statistical demand relations between X_{1s} and X_{2s}. For summer lemons, also, the results for the individual years are in table 5, page 73.

Figure 22. Summer Fresh Lemons; U. S. Supply, Actual and Computed "Optimum" at F.O.B. Level, from 1922.



is based on the premise that the supplies of the two seasons are freely variable and independent of each other. But that is so only to a limited extent. The preceding analysis, however, is informative in that it indicates the differentials between actual supplies made available to the fresh market, winter and summer separately, and the corresponding levels of seasonal supplies that would have maximized

Figure 23. Distribution of Total Fresh Lemon Shipments Between Summer and Winter Seasons, Actual and Computed "Optimum" at F.O.B. Level, from 1921–22.



gross money returns at the f.o.b. stage of marketing.

Another type of question pertaining to the supply levels of winter and summer fresh lemons is pertinent here. The question may be put in the following terms: With a given total supply of fresh lemons to be allocated among the winter and summer seasons, what allocation will yield maximum gross money returns from the sale of the quantities in both seasons? The same type of question may be put in terms of the sum of the total quantities actually supplied, in a given year, to the summer and winter markets. On that basis, the question pertains to allocating supplies to the summer and winter markets in such manner that the total for the two seasons equals the corresponding total actually supplied, but the distribution of supplies between the two seasons yields maximum gross money returns from both seasons together.*

By again using the statistical demand relations between price and quantity of fresh lemons, for summer and winter respectively, we may estimate the seasonal distribution of fresh lemons which would yield maximum gross money returns at the f.o.b. level. Such quantities are shown in figure 23, page 52; the sum of the summer and winter quantities, derived for each year, equal the sum of the seasonal quantities actually experienced in each year.†

Figure 23 shows the annual fresh quantity distributed between the summer and winter seasons. The series indicated as "optimum" reflects the quantities which were to be supplied if total maximum gross money returns were to have been realized from the supplies of both the summer and winter seasons. The figure indicates a tendency prevailing toward the "oversupply" of the winter quantities and a corresponding "undersupply" of the summer shipments; that is, if the attainment of maximum gross money returns from both seasons together is viewed as the standard of allocation between the winter and summer seasons.

The same type of relation is illustrated in figure 24, where the seasonal distribution is expressed in terms of per cent of the sum of the quantities actually supplied during the summer and winter seasons. As a percentage of the total annual supply of fresh lemon supplies available to the market, summer lemons have tended to be in an "undersupply" position, and winter lemons have tended correspondingly to be in an "oversupply" situation. Here, again, the criterion is the realization of maximum gross money returns for the crop year as a whole by distributing the annual fresh supply between the winter and summer seasons.

The evidence suggests that over the years there has been a slight trend in the summer and winter distribution of fresh lemon supplies. The summer proportion has tended somewhat to decrease, and the winter proportion to increase correspondingly. But the change has not been a marked one—less than 5 per cent over the period as a whole—and practically all of the change developed in the first half of the period. Since the middle of the 1930's, the summer and winter proportions have been remarkably stable, and

* The solution may be indicated as follows: Let $p_1 = a - b_1 q_1$ and $p_2 = a_2 - b_2 q_2$ where p and q are price and quantity, respectively; $q_1 + q_2 = Q$, a given value such as total annual fresh shipments; and subscripts 1 and 2 pertain to winter and summer seasons, respectively; then

$$q_1 = \frac{a_1 - a_2 + 2b_2 Q}{2 (b_1 + b_2)}; \text{ and } q_2 = Q - q_1$$

† The "optimum" (or gross-revenue maximizing) distribution between summer and winter was determined by deriving the annual net statistical demand relations between price and quantity, for summer and winter fresh lemons, respectively, by using the equations on pages 32 and 37; and from such equations, the "optimum" distribution each year was derived as indicated in the preceding footnote. The results for the individual years are in table 6, page 74.

the minor fluctuations were about a nearly level trend.

Of some significance is the apparent fact that the actual proportions of summer and winter fresh supplies made available to the market did not vary widely from the proportions necessary to yield maximum gross money returns from the sale of the annual fresh supply, summer plus winter. In most years, the discrepancy did not exceed 5 per cent. One may interpret such evidence as an indication that the marketing organizations shipping fresh lemons have, in the aggregate, distributed reasonably well the annual fresh supply between the winter and summer seasons. Although the seasonal distribution is in part determined by the production process, the latitude allowed by varying the picking time and holding in storage for curing permits a large degree of flexibility in distributing the supply going to fresh market between the summer and winter seasons. Within the permissible range of distribution, the seasonal allocation between winter and summer may be judged to have been well accomplished.

Allocation of the Crop to Fresh Market and to Processing. The preceding analyses of supply allocation have been oriented to and pertain directly to the distribution of fresh shipments between the winter and summer seasons. Allocation to processed lemon products outlets was considered only indirectly, and only in the sense that the supply not shipped to the fresh markets would be available for processed utilization. There appears to be the suggestion, in the available evidence, that in most years the marketing of the lemon crop has followed such a pattern. There does exist, however, a question concerning the "optimum" allocation of the lemon crop between the fresh and processed markets. Yet, such a question is not very meaningful unless the "optimum" is specified in reasonably precise terms.

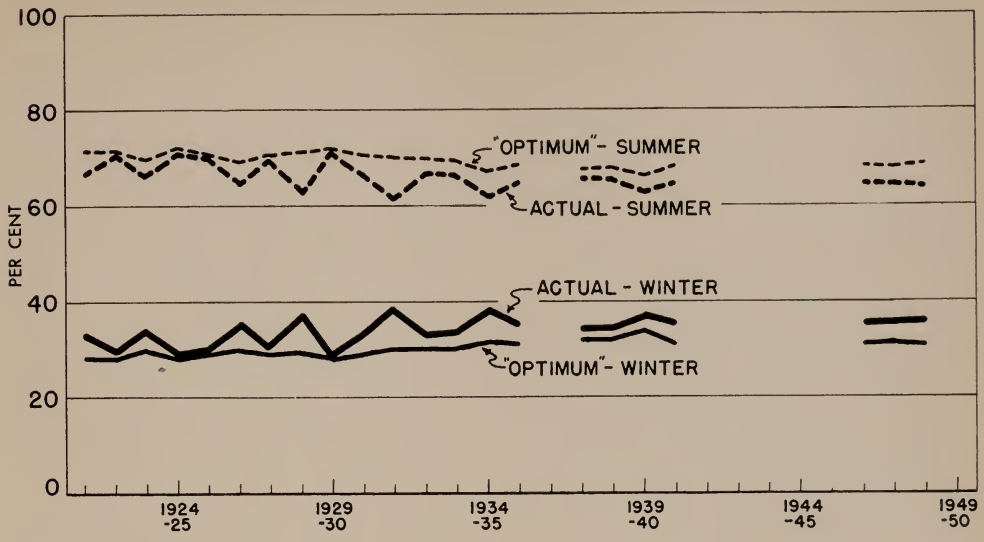
Various criteria may be selected for specifying the "optimum" allocation between the fresh and processed markets. To some extent, the particular selection adopted depends upon factors other than market conditions. For example, important equity problems may exist. For the present, we shall abstract from such equity questions and limit the analyses to market conditions exclusively. Later we shall bring in some equity considerations and note how they, when superimposed upon the market situation, affect the results. Hence, for now, we shall proceed with a consideration of various criteria which may be viewed as the objectives of allocating the lemon crop between the fresh and processed markets.

One may consider the view that the desirable distribution of the lemon crop between the fresh and processed outlets is one which equalizes the prices received from them.* The prices may be either in gross terms, or in net terms after costs have been reflected. Compared with conventional practice in the lemon industry, a policy of price equalization among the fresh and processed outlets would entail a substantial increase of the quantity shipped for fresh use and a corresponding decrease in the quantity processed. But other than attaining price equalization, such a distribution policy would have little point. Inspection of the fresh and processed-use prices in figure 20, page 48, clearly shows that the industry has not followed the policy of equalizing prices or returns from the fresh and processed outlets.

* The distribution would be as follows, where: $p_1 = a_1 - b_1q_1 + c_1q_2$, and $p_2 = a_2 - b_2q_2 + c_2q_1$ are demand functions; p and q are price and quantity, respectively; subscripts 1 and 2 are fresh and processed, respectively; and $q_1 + q_2 = Q$, a given value such as the total crop to be distributed. To equalize prices from the two outlets, the distribution is such that

$$q_1 = \frac{(a_1 - a_2) + (c_1 + b_2)\,Q}{(b_1 + c_2 + c_1 + b_2)}, \text{ and } q_2 = Q - q_1.$$

Figure 24. Percentage Distribution of Total Fresh Lemon Shipments Between Summer and Winter Seasons, Actual and Computed "Optimum" at F.O.B. Level, from 1921–22.



Another allocation policy considered may be that of equalizing money value (price times quantity) from the fresh and processed utilizations.* Here, also, the money value may be either in gross terms, or net terms after costs have been reflected. Such allocation policy would be much different from that which has been followed, and the reason is obvious; the returns from the whole crop would be reduced much below the levels which have been experienced. Review of the allocation data clearly indicates that the lemon industry has not followed the policy of equalizing the money values of the volumes channeled to the fresh and processed markets. This raises the question of what allocation policy has been followed. Before inquiring into that question, however, we shall consider a third possible policy of allocation between the fresh and processed outlets.

Rather than viewing price-equalization or returns-equalization as the objective of allocating a given lemon crop between the fresh and processed markets, another objective may be selected which from many viewpoints may be considered as more rational. This third allocation policy may be termed as revenue maximization; it involves distributing the crop among the two outlets in such a manner that the money revenue derived from both outlets together sums to the largest amount possible or a larger amount than could be obtained by using any other allocation.† There may be practical or administrative reasons why an allocation

* Such a distribution would be as follows, where: $p_1 = a_1 - b_1q_1 + c_1q_2$, and $p_2 = a_2 - b_2q_2 + c_2q_1$ are demand functions; p and q are price and quantity, respectively; subscripts 1 and 2 are fresh and processed, respectively; and $q_1 + q_2 = Q$, a given value such as the total crop to be distributed. To equalize money returns from the two outlets, the distribution is such that the quadratic equation $(b_1 + c_2 - b_2 - c_2)\,q_1^2 - [a_1 + a_2 + (c_1 - 2b_2 - c_2)\,Q]q_1 + (a_2 - b_2Q)\,Q = 0$ is solved for the value q_1; and $q_2 = Q - q_1$.

† The revenue-maximizing distribution may be indicated as follows, where: $p_1 = a_1 - b_1q_1 + c_1q_2$, and $p_2 = a_2 - b_2q_2 + c_2q_1$ are demand functions; p and q are price and quantity, respectively; subscripts 1 and 2 are fresh and processed, respectively; and $q_1 + q_2 = Q$, a given value such as the total crop to be distributed. The revenue-maximizing distribution is such that

$$q_1 = \frac{a_1 - a_2 + (2b_2 + c_1 + c_2)\,Q}{2(b_1 + b_2 + c_1 + c_2)}, \text{ and } q_2 = Q - q_1.$$

policy yielding maximum revenue cannot or should not be followed, but from the view of objective standards or alternative policies to be considered, it is of considerable significance.

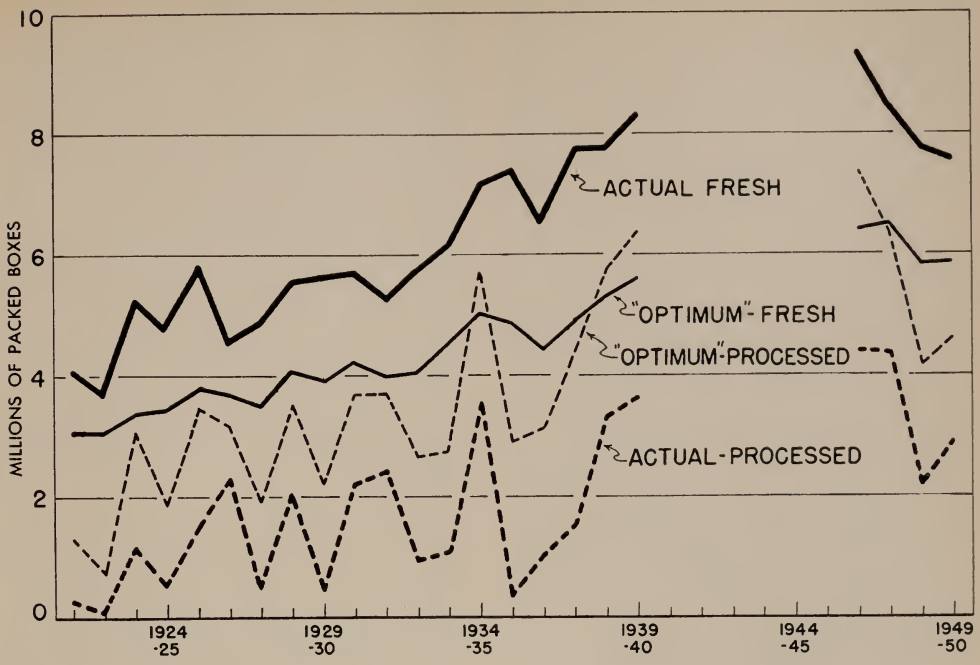
In connection with allocating a given size of lemon crop between the two outlets, fresh and processed, there arises the question of whether the two outlets are related in demand. At first thought, one may have the view that the fresh and processed outlets are related in demand, and competitive. But such a view must be limited to edible utilizations, in the sense that the housewife purchases fresh lemons or processed lemon products depending on relative prices. As noted earlier, and as will be shown in more detail below, that portion of the crop used for lemon processing is divided into a number of different products, some of which are not directly competitive with fresh lemons. Hence, it is necessary to investigate statistically the extent to which, in the past, the total or aggregate demand for processed lemons is competitively related to the total demand for fresh lemons. The resulting indications are pertinent since the allocation of the crop between the fresh and processed outlets is affected.

Testing Demand Relationships: Fresh and Processed Markets. There are several procedures of testing the demand relations between the fresh and processed markets. One obvious procedure is to use the summer and winter demand equations for fresh lemons, discussed in the previous section. This may be done by inserting the price and quantity, respectively, of processed lemons into the demand equations. The results of such procedure are summarized in table 8, page 76. As may be noted, such procedure provides no significant evidence that the demands are related. Here, it may be noted again, processed lemons in the aggregate are reflected. Hence, the results do not provide evidence concerning the demand relations between particular processed lemon products, such as canned lemon juice, and fresh lemons. But a major shortcoming of the analyses, the results of which are summarized in table 8, is that the prices for fresh lemons are on an f.o.b. basis while the prices for processed lemons are on an "on-tree" basis. Another characteristic, which may also be a shortcoming, is that the prices and quantities for processed lemons pertain to the entire crop year, while the prices and quantities for fresh lemons are segregated into summer and winter, with each season described by its own separate equation. For these reasons, it is worth while to look further into the question of demand relations between the fresh and processed portions of the lemon crop.

There are available annual average "on-tree" prices for lemons processed and shipped fresh, respectively. Such price data were used in conjunction with the total annual quantities shipped fresh and processed in order to detect measurable and significant demand relations between the total fresh market and the total processed market. Since temperatures are known to affect the demand for fresh lemons, they are reflected in the analyses. The results of this analysis are summarized by the equations in table 9, shown on page 77.

None of the equations offers statistically significant evidence that the demands for fresh lemons and lemons for processing have generally in the past been interdependent in a market sense. This apparent situation may be explained by one or both of the following rationalizations. First is the fact, noted earlier, that the processed market is considered in the aggregate, wherein actually there are a number of processed outlets and markets. Second is the apparent fact that during the period under consideration lemon marketers have oriented their primary attention to the fresh market; the processed outlet was viewed primarily, if not entirely, as a by-product or salvage operation.

Figure 25. Distribution of Lemon Crop Among Fresh and Processed Outlets, Actual and Computed "Optimum" at On-Tree Level, from 1921–22.



Actual and Derived Volumes of Lemons Marketed Fresh and Processed. We may now note how the actual distribution of the lemon crop between the total fresh and total processed outlets, through the years, compares with distributions which would have maximized the sum of total "on-tree" revenue from both outlets.*

In figure 25, above, are shown the actual annual allocations of lemons to the fresh and processed outlets, as well as the statistically estimated "optimum" allocations. The "optimum" allocations have been computed so that the on-tree value of the total supply used (fresh and processed) would be at a maximum.†

Examination of figure 25 suggests several significant characteristics of the utilization allocation pattern. The trends of actual and optimum fresh quantities are largely similar; also the year-to-year changes in the two series are generally in the same direction, although there are several exceptions. Over the period as a whole, the level of actual fresh-use quantities is above the "optimum" levels for the respective years.

With respect to the processed-use patterns, several characteristics may be

* The revenue-maximizing distribution may be indicated as follows, where: $q_1 = a_1 - b_1p_1$, and $q_2 = a_2 - b_2p_2$ are demand functions; p and q are price and quantity, respectively; subscripts 1 and 2 are fresh and processed, respectively; and $q_1 + q_2 = Q$, a given value such as the total crop to be distributed. The "on-tree" revenue-maximizing distribution is:

$$q_1 = \frac{a_1b_2 - a_2b_1 + 2b_1Q}{2(b_1 + b_2)} \; ; \; q_2 = Q - q_1.$$

† The "optimum" (or gross-revenue maximizing) distribution between fresh and processed utilization was determined by deriving the annual net statistical demand relations between quantity and price, for fresh and processed uses, respectively, by using equations 8 and 11 in table 9, page 77; and from such equations, the "optimum" distribution each year was derived as indicated in the preceding footnote. The results for the individual years are in table 10, page 78.

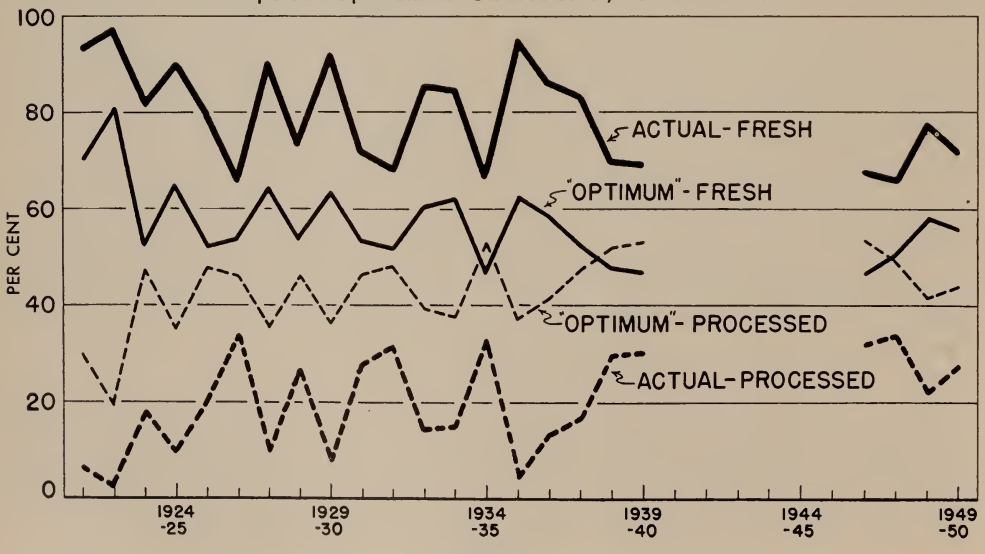
noted. There, also, the trends of actual and "optimum" processed quantities are largely similar; and the year-to-year changes in the two series are generally in the same direction. Over the period as a whole, the level of actual processed-use quantities is below the "optimum" levels for the respective years.

From the view of maximizing on-tree total returns, the evidence so far suggests—but does not show conclusively—that the industry has tended somewhat to overship to the fresh market and channel correspondingly lower quantities to the processed market outlets. There may have been, of course, rational reasons for such practice; and later we shall consider some of them. But here it may be helpful to review the actual and "optimum" allocation patterns in a different manner so as to bring out the differential characteristics in bolder relief.

Figure 26, below, shows the annual percentage distribution of the total supply marketed, as between the fresh and processed outlets, with both the actual and "optimum" percentages for comparison. Here also, the percentage trends are broadly similar for both the actual and "optimum" series and the year-to-year changes are also generally in the same direction for the actual and "optimum" series; these two characteristics apply to both the fresh and processed outlets. Figure 26, though, clearly emphasizes the gap between the levels of the actual and "optimum" percentages. In the fresh outlet the "optimum" percentage level is under the actual percentage level. In the processed outlet, the "optimum" percentages are greater than the actual ones. This is the same evidence, noted earlier, that from the standard of maximizing on-tree returns from the total lemon supply marketed, allocation to the fresh outlet has probably been too high and allocation to the processed outlet has probably been too low.

Over the period as a whole since 1921–22, a persistent tendency to narrow the gap between the actual and "optimum" allocations has not prevailed. But there is a marked difference between the prewar and postwar years. This may be fortuitous, since there are only four postwar years which have been observed. Considering the record available, though, the percentage differentials, in the prewar years, between the actual and optimum relative allocations varied from

Figure 26. Percentage Distribution of Lemon Crop Among Fresh and Processed Outlets, Actual and Computed "Optimum" at On-Tree Level, from 1921–22.



about 15 per cent to slightly over 30 per cent. The annual differentials fluctuated about a horizontal trend at an average level of about 23 per cent. In the postwar years, however, the annual differentials varied from 15 to slightly over 20 per cent, and averaged close to 18 per cent. Hence, there is some basis for concluding that in the postwar years, not only have the allocation distributions generally been closer to optimum than in the prewar years, but also the year-to-year departures have tended not to be so wide. The conclusion tentatively reached earlier, however, still stands, even in the postwar years; a somewhat larger proportion of the crop allocated to the processed outlet would very likely have resulted in greater on-tree returns from the total crop marketed.

The preceding analysis of allocation of the lemon crop among the fresh and processed outlets requires, at this point, several qualifying comments. First, it may be noted that the "optimum" allocations developed are based on statistical estimates, rather than upon precise information, of the demands for lemons going to fresh market and to processing. Hence, a margin of error surrounds the estimates. Also, it should be noted that the statistical relations developed reflect past experience over a period during which changes have occurred in the lemon industry. Therefore, as new conditions develop and arise, they may not be sufficiently well explained by the relations based on earlier experience. Yet such a situation often exists when attempting to analyze industry developments in quantitative terms. Hence, in the lemon industry, which is apparently now in a transition phase where the significance of the processed products is beginning to gain more attention, the market structure and crop allocation practices of earlier years can be projected only cautiously into the future.

Another qualifying comment is that the results cited are from an analysis which assumed that the fresh and processed markets were independent in demand, as suggested by the statistical demand analysis for the period as a whole. If it is assumed, however, that the fresh and processed markets are related in demand—a characteristic which appears to have developed more in the recent postwar years — the results are altered to some extent. The "optimum" level for fresh lemons is nearer to, but still less than, the actual level experienced; and the "optimum" level for processed lemons is nearer to, but still greater than, the actual level.*

Therefore, rather than insisting that the optimum percentage allocation of the lemon crop between the fresh and processed outlets for the next several years is about 55 per cent for the fresh and about 45 per cent for the processed, a less firm projection is advisable. It might be expressed as follows: During the next several years, consideration might well be given to gradually decreasing the percentage of the crop allocated to the fresh outlet and correspondingly increasing the percentage of the crop going to the processed outlet. Such a change in crop allocation, though, merits consideration only if industry policy and objective are oriented in the direction of increasing the industry total returns, on-tree basis, from the lemon crop.

Another point which should be noted with respect to the preceding analysis is that it is in some respects considerably simplified. Allocation is considered between the fresh outlet and the total processed outlet. But in fact, the processed outlet includes a number of separate products. The relative proportions of the products vary from year to year, as well as their prices. Hence, a complete analysis would also indicate "optimum" allocations of lemons for use in the manufac-

* The analysis, with related demands, was based on equations 1 and 2, table 9, page 77, to which was applied the procedure indicated in the second footnote on page 55.

ture and sale of the various processed products. But adequate statistical data are not available to undertake such an analysis, and with the marked growth of certain products and the introduction of new ones very recently, one may well question the value of such an analysis at this stage for projection purposes. Yet it is necessary to inquire, in less formal terms, into the developments within the processed lemon products group.

Various Types of Lemon Products. The principal lemon products produced include the following: frozen lemonade concentrate; lemon beverage base; canned or bottled single-strength lemon juice; citric acid; powdered lemon juice; sodium citrate; lemon oil, cold-pressed or distilled, single-strength or concentrated (terpeneless); dried lemon peel; candied lemon peel; pectin; cattle feed; and marmalade.

Lemons used for processing may be classed according to utilization into two general groups: those used for juice products, and those used for products such as citric acid and sodium citrate. This classification has significance in that the juice products generally yield a greater value per ton of lemons processed than do the citric acid or sodium citrate.

Figure 27, below, shows the percentage distribution of lemons processed into juice and other products for the period since the 1941–42 season. This graph is of interest in that it emphasizes the rapid increase in the relative importance of juice product uses since 1946–47. During the war years, juice products manufacture was stimulated by the Armed Services and lend-lease demand. In 1946–47, approximately 24 per cent of all lemons processed were utilized in juice products. In 1949–50, juice products took 84 per cent of the total lemons processed. For the latter year, however, the total lemon supplies were smaller.

This sharp increase in the relative importance of juice products stems from the increase of two products, frozen lemonade concentrate and frozen concentrated lemon juice. This change is reflected in figure 28, page 61, which shows

Figure 27. Percentage Distribution of Lemons for Processing: Juice and Other Uses, from 1941–42.

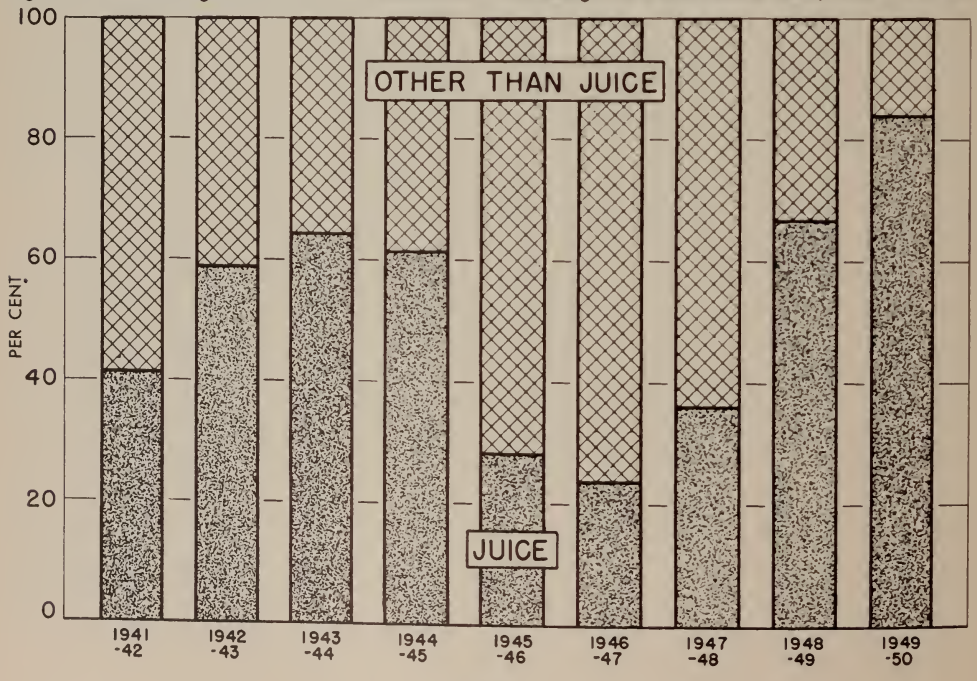
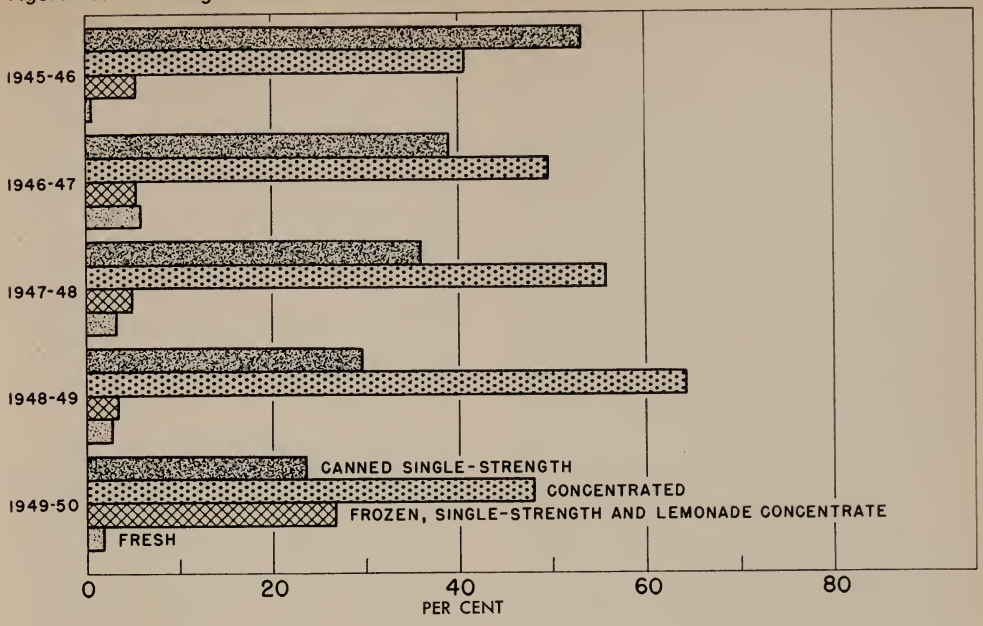


Figure 28. Percentage Distribution of Lemons Processed for Various Juice Products, from 1945–46.



the utilization of lemons processed for the several juice products. The greatest change occurred in frozen single-strength juice. Included in this category is the new product, frozen lemonade concentrate. In 1949–50, the first year of production on a commercial scale, 1,702,209 gallons of frozen lemonade concentrate were produced, absorbing the equivalent of nearly 19,000 tons of lemons. Another new product, frozen concentrated lemon juice, also took a substantial volume of fruit. In 1949–50, almost 91,000 gallons of frozen lemon concentrate were produced, equivalent to about 7,000 tons of fruit. Thus, these two new products provided an outlet for about 26,000 tons of lemons.

A relatively significant volume of lemons move into the manufacture of citric acid and sodium citrate. But the output of these products by the citrus industry amounts to only some 10 or 15 per cent of the total production, since most of the products are supplied by chemical and allied industries.

A third major processed lemon product is lemon oil. Most of the lemon oil produced in this country is made by passing the cut fruit through presses in such a way that both the juice and the oil are extracted. The two are then separated by a centrifugal process. Other devices press the peel alone. There is also some oil produced by distillation. A third type of lemon oil, terpeneless or concentrated oil, is made by fractional solution in alcohol or by fractional distillation of the cold-pressed oil. Over the period since 1940, production of lemon oil has averaged about 1,000,000 pounds per year. During that period, cold-pressed oil has increased in importance relative to distiiled oil. In 1939–40, about 75 per cent of the total oil produced was cold-pressed oil. In 1947–48, about 93 per cent of the total was cold-pressed. Lemon oil is essentially a by-product using the oil from all lemons processed.

There is a wide range in the per ton gross returns to the processor, depending on the product made from the lemons. Citric acid and sodium citrate are low-value products (fig. 29, page 62), with gross returns to the processor, in 1949–50, of $9.48 and $14.86 per ton of lemons

processed. Cold-pressed oil is also a low-value product with gross returns to the processor of $13.95 per ton of fruit processed in 1949–50. The juice products are all considerably more valuable. Concentrated lemon juice, beverage base, and single-strength juice other than canned, had gross returns to the processor of about $64 to $70 per ton of fruit used in 1949–50. Canned single-strength juice had gross returns to the processor of about $150 per ton of fruit processed; the comparable figure for frozen lemonade concentrate and canned lemonade base was $216 per ton of fruit processed.

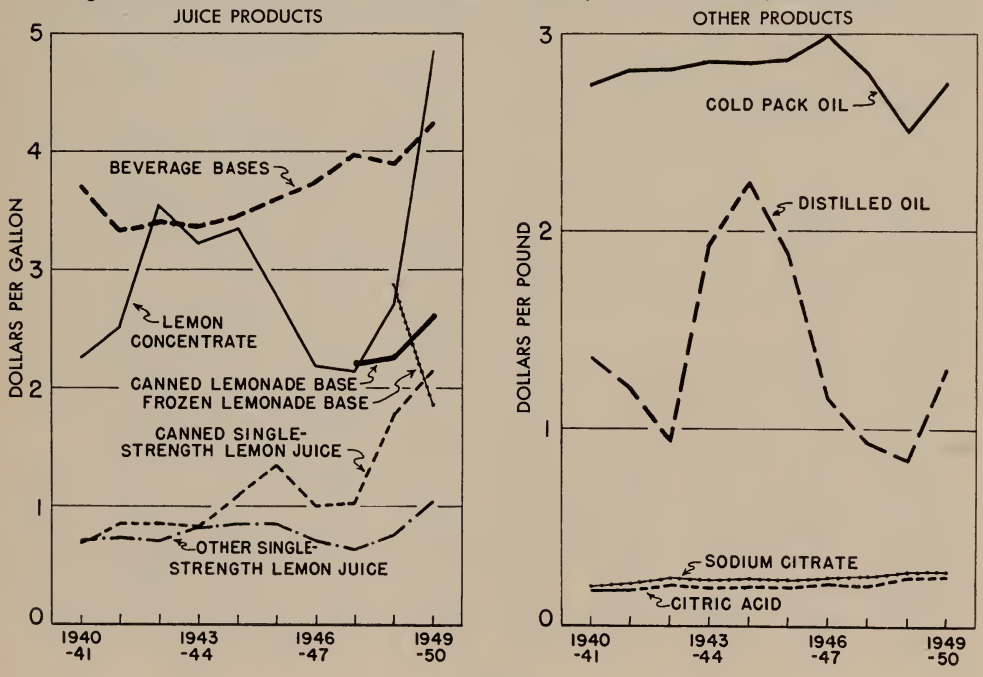
Prices of lemon juice products have moved generally upward during the past ten years (fig. 29). Frozen lemonade concentrate is an exception. In 1948–49, only a small amount was processed and the price was relatively high. The great increase in the volume of this product processed during 1949–50 was accompanied by a corresponding decline in the price. Juice product prices declined after the end of World War II, but since have more than regained their loss.

Nonjuice lemon products prices recenly have been at levels comparable to those of 1940. Prices of lemon oil rose during World War II, dropped to below prewar prices immediately after the war, but have risen somewhat during the past year. Prices of citric acid and sodium citrate have remained relatively steady over the past decade, rising but 7 cents and 8 cents per pound, respectively, during the ten years. This is an example of price rigidity associated with many industrial products, in contrast with price-flexibility characteristic of most agricultural products.

Timing and District Origin of Lemons Sent to Processing. In addition to volume and price differences among the various lemon products, there exist important differences in the timing and district origins of the lemons sent to processing. First, we may consider the timing of movement to processing.

There is a pronounced seasonal variation in the movement of California lemons to processing. As the lemon marketing season opens in November, move-

Figure 29. F.O.B. Prices of Processed Lemon Products, Juice and Others, from 1940–41.



ment to processing is relatively small and decreases still more during the next month, reaching a seasonal low in December. Volume processed then increases steadily to a peak in May, remains high during June and July, and decreases rapidly during September.

Processing of the winter lemon crop starts at a relatively low level in November and gradually increases to a peak at the end of the winter season about the last of April. This is true for all producing districts except northern California, where the peak in processing is reached late in February.

Processing of the summer crop starts at a high level in May and then gradually declines to a low in October. While these seasonal patterns are similar for all districts, there is less variation in shipments to processing from the San Diego area than from the others.

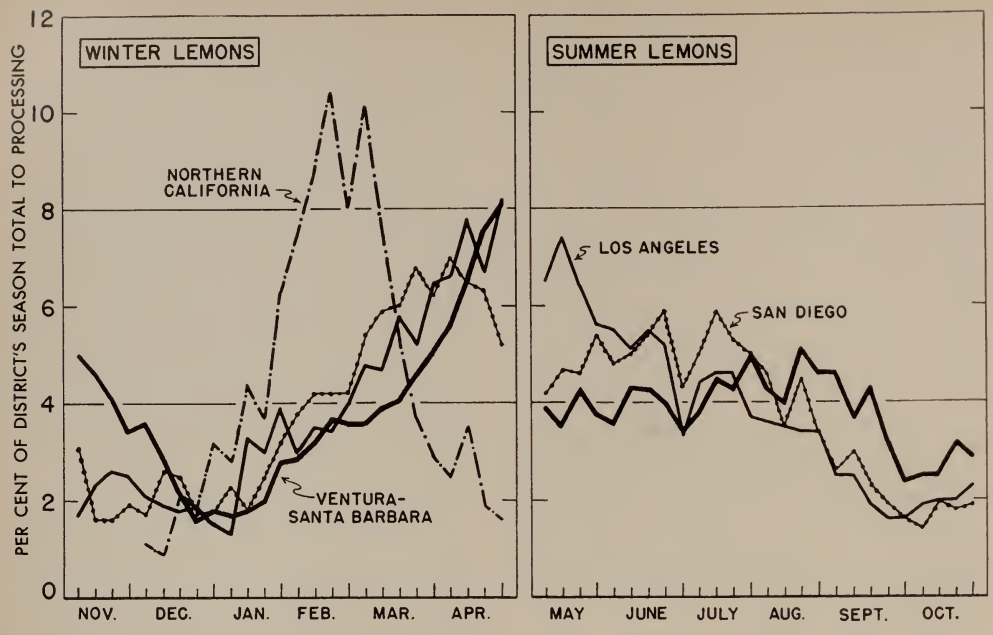
The relative volumes of lemons going to processing from the several producing districts also follow a pattern during the year. The proportionate volume originating in the Ventura-Santa Barbara district, the one with the heaviest volume, is about half as much (in percentage terms) during the four-month period January through April as during the rest of the year. The Los Angeles district, in contrast, becomes relatively most important in the January–April period. But the San Diego district maintains a fairly stable percentage, about 10 per cent of the state's total movement to processing, during the entire year. It is clear, then, that the district origin of lemons going to processing, as well as the timing of the movement, is of significance in considering the allocation of the lemon crop among the fresh and processed outlets.

The interaction among district origin and timing of the movement to processing is only partly identified unless distinctions are also made between the summer and winter seasons, since the market for fresh lemons varies between the summer and winter months. During the winter lemon season, about 35 per cent of the state's total lemons for processing come from the Ventura-Santa Barbara district, and about 50 per cent from the Los Angeles area. During the summer season, however, the relation is reversed; about 55 per cent of the total processed originates in the Ventura-Santa Barbara district, and about 35 per cent comes from the Los Angeles district. As noted above, the San Diego district furnishes about 10 per cent of the total throughout the year. All northern California lemons processed move during the winter season, this district furnishing about 3.5 per cent of the total winter lemons processed.

The seasonal variations, winter and summer separately, as well as for the four lemon producing districts respectively, are shown in figure 30, page 64. It summarizes the complex interaction existing within the movement of lemons to processing—with the timing, district of origin, and seasonal characteristics reflected. With the exception of northern California, the remaining districts have broadly similar seasonal patterns, although important differences exist, as noted earlier, in the absolute and relative volumes from the respective districts. The data considered clearly indicate that each district has its own problems and characteristics. For that reason, allocations and movement to processing and the fresh market, respectively, can be considered on a statewide basis only in very broad terms. In an operational sense, districts and smaller units must be considered.

The interrelations existing among the timing, seasonal aspects, and district origins of lemons moving to processing have been discussed to indicate the far from simple conditions. Also of significance is the fact that grower equities may be involved. Whether such is so or not depends in large part upon the type of marketing organization through which the lemons pass.

Figure 30. Seasonal Variation in the Movement of California Lemons to Processing, by Producing Districts.



The Question of Grower Equities. If the lemons are sold by individual growers to private fresh-shipping or processing concerns, the equity problems are essentially no different than those existing in any commodity sold and bought under private auspices. The lemon grower-seller attempts to seek out that buyer, whether he be a fresh-shipper or processor, with whom he can bargain most profitably. The lemon buyer, in turn, whether he be a fresh-shipper or processor, will attempt to purchase as cheaply as he can the types of fruit in which he is interested. The price determinants here are similar to other sale-purchase private transactions.

If the lemon grower belongs to a cooperative to which he forwards his fruit for marketing, certain equity problems arise in connection with allocating the cooperative's total volume of lemons among the fresh and processed outlets. If the cooperative attempts to follow some policy as to allocation among the fresh and processed outlets—not necessarily a policy of maximizing gross (or net) revenue from the total crop—there is involved the problem of imputing returns to the various participating members. Under a policy of revenue maximization for the cooperative as a whole, the usual pooling systems could result in inequities in the sense that comparable grades and sizes of fruit would yield different returns, depending upon the outlet (fresh or processed or type of processed product) to which the pool fruit is allocated.

A cooperative might follow a profit-maximizing policy which includes the distribution of total revenue among the individual growers in accordance with some proportionality system and which reflects differential grades, sizes, pound-acid rating, and other important characteristics by the use of a modified pooling system. Such a plan could approximate the realization of short-run maximum revenue for the cooperative as a whole, but some individual growers may receive lower returns and other growers may receive higher returns than they would have received under a different policy, such as those presently

followed. There remains, therefore, the problem that the attainment of maximum (or increasing) gross revenue to the cooperative as a whole need not always be consistent with increasing the returns to each of the individual growers participating in the cooperative. Hence, as consideration is given to allocating the flow of lemons to the fresh market and to processing, respectively—either by the returns-maximizing plan, a variant of it or some other rational plan—the problems of maintaining equity among individual grower participants remain in the forefront. As the processed outlet gains increasing recognition, modifications may be necessary in pooling systems and procedures for the maintenance and balance of equities among individual participants.

That the allocation of somewhat greater supplies to the processing outlet may well result in greater total returns to the lemon industry has been suggested by consideration of the analyses reviewed earlier. Yet, reactions on lemon importations must not be neglected. The transition which the lemon industry seems to be experiencing at present—in the sense of an orientation of interest to the potentialities latent in the balanced use of the fresh and processed outlets—is evidenced by a recent California marketing order for lemon products. The order merits review so that its role and position may be evaluated.

The California State Marketing Order for Lemon Products. On March 10, 1951, a California state marketing order for lemon products became effective. The order provides for volume regulation, grade and size regulation, sales promotion, and the conducting of industry research pertaining to lemon products.

The order is administered by an advisory board of eight members, with alternates provided for each member. Representation on this board is provided in the following manner: (1) Any cooperative which received or processed more than 50 per cent of the total volume of lemons processed in 1949–50 shall be represented by four members and four alternates; (2) all other cooperatives shall have, collectively, one member and one alternate; (3) other processors shall have the remaining three members and three alternates.

The board is directed to investigate economic and marketing conditions and, on the basis of the information obtained, may recommend the establishment of the percentage of lemons to be acquired by processors in any marketing season, which shall be: (1) free tonnage, or (2) stabilization pool tonnage. The total of the free and stabilization tonnage is to equal 100 per cent. All recommendations of the board are subject to the approval of the Director of Agriculture of the State of California.

On receipt of a recommendation that marketing percentage regulations be established, the Director may issue such regulations, establish such percentages, and notify the board. The board, in turn, notifies the processors.

The percentage of lemons designated as "free tonnage" is exempt from the restrictions of the order. "Stabilization pool tonnage," however, is subject to the order and all regulations issued under it.

Free tonnage and stabilization pool tonnage are computed by applying the applicable percentages to all lemons acquired by each processor. Excepted, however, are those lemons which have been included in the computation for a prior holder, unless the processor files with the board a request to have such computation made on the basis of the total tree crop from any designated grove. Such request is to be granted only to processors who declare their total tree crop from the designated grove is for processing only; and, in addition, the processor must show evidence that such crop is not included during the marketing season in any computation of alloca-

tion for fresh shipment pursuant to any federal or state marketing control program applicable to lemons. In such an event, no stabilization pool tonnage obligation is to arise from that part of the total tree crop equal to the estimated industry average shipped in fresh form during the respective marketing season.

The board may dispose of stabilization pool tonnage in its original form, or after conversion into approved products, or by any other means which will tend to effectuate the declared purpose of the act. The board, also, on approval of six members, may fix prices for stabilization pool tonnage.

On the basis of information available to it, the board may recommend to the Director the issuance, modification, suspension or termination of minimum grade or size regulations for lemons which may be acquired by processors or for stabilization pool lemons. The board is authorized to prepare and administer plans for promoting the sale of lemon products without reference to private brands and is authorized to participate in or conduct research into the distribution, production and processing, or minimum quality specifications for processed lemon products. The act authorizes the Director to investigate and stop "unfair trade practices" in the processing, sale or distribution of lemon products.

The program is financed by an assessment of up to 75 cents per ton on all lemons acquired by processors, or financing may be from money accumulated in the stabilization pool fund. After deduction of necessary expenditures, all money remaining in the stabilization pool is to be paid on a prorata basis to the participants in the pool.

It is clear that two of the major provisions of the marketing order for lemon products are to enable the industry, with state legislative authority, to influence the grade and size characteristics of lemons going to processing and to influence the volume flow of lemon-processed products to market outlets. In that sense, the order is broadly similar to a number of currently effective marketing orders for other crops.

Major marketing organizations may significantly influence the crop allocations to the fresh and processed outlets on the basis of their own policy and marketing decisions. After such allocations are made, the organizations, along with the rest of the industry, may then operate within the present framework of separate orders for the fresh and products markets.

Promoting the sale of lemon products is one of the objectives of the lemon products order. Consumer and trade education and advertising and sales promotional activities are pertinent here. Well-planned and well-prosecuted campaigns of this type have apparently been effective in other commodities, such as the advertising activities on clingstone peaches by the Cling Peach Advisory Board, operating under a California state marketing order. That certain lemon products, such as canned lemon juice, are to some extent competitive in consumption with fresh lemons does not necessarily mean that the markets for both the fresh and canned juice products are limited one by the other. One may well conjecture that the markets for both fresh lemons and processed lemon products can be expanded. There are many examples where the sales of fresh and processed products have increased simultaneously. One may cite vegetables, such as peas and asparagus, in which the sales of fresh, canned, and frozen have expanded together. The same applies to berries and other products.

In lemons, however, there exists an aspect which does not prevail in most other products marketed as fresh, canned, and frozen. Items such as fresh peas and asparagus or berries are marketed mainly on a highly seasonal basis during a portion of the year. The fresh product, being available in plentiful supply dur-

ing only a part of the year, has a temporal advantage. Consumers tend to be interested in the fresh product when in season because of limited availability, and only at relatively high prices during the rest of the year. Fresh lemons, however, are in plentiful supply during all months of the year, and for that reason, might not have the type of temporal advantage characteristic of the fresh products noted above. Hence, the promotion of fresh and processed lemon products might be oriented in the directions of complementary rather than competitive uses. Along such lines, the markets for both the fresh and processed lemon products may be developed and expanded.

The lemon products order specifies that the board may recommend (to the State Director of Agriculture) the issuance, suspension or termination of minimum grade or size regulations for lemons which may be acquired by processors or for stabilization pool lemons. In that connection, it might be noted that different characteristics of lemons affect their acceptability for the fresh market in contrast with the processed outlets. The quality factors pertinent for lemons shipped fresh include characteristics such as general appearance, color, size, and shape. Acceptability of lemons for processing, however, is based on their performance in a juice-acid test; color, size, shape, and similar appearance characteristics have a bearing only to the extent that they affect the juice-acid rating.

It is reasonably clear that a different set of acceptability standards is appropriate for lemons going to processing than for those shipped to the fresh market. It is likely true that practically all lemons could be physically acceptable for processing, whereas only part of the crop is acceptable for fresh shipments. But the essential distinction is the division of the crop into fresh and processed portions, not so much along lines which represent physical acceptability but rather along lines which represent economic profitability. The juice-acid test is important for processing acceptability because it reflects the yield-returns which may be realized; and appearance characteristics are important for fresh shipping acceptability because they influence the returns to be realized from the sale of the fresh lemons.

In view of the experience gained in other products which enter the fresh and processed markets, different varieties of lemon trees may be developed and cultivated for the fresh and processed outlets. Such practice has developed in a number of vegetables, canned and frozen. The packers often even furnish appropriate varietal seeds to insure obtaining products which are adaptable for processing. As the processed outlets expand, lemon varieties best suited for processing may be developed; and, in turn, there may be further development of varieties having appropriate characteristics for the fresh market. Citriculturally, varieties of lemons may be developed which sacrifice appearance in favor of increased juice-acid contents; such varieties would be best adapted for use in processing. This is only brought out to suggest that, as the lemon marketing structure varies in view of the changing significance of the fresh and processed outlets, there may be reactions on the production side of the lemon industry.

The appropriate distribution of the lemon crop among the fresh and processed outlets is undoubtedly one of the major marketing problems facing the California-Arizona lemon industry. Although the total volume of lemons going to processing has not expanded in the past several years, a significant change is developing. The change is reflected in the increasing proportion of the higher value processed lemon products. It is significant as an index of changing market structure and also significant in that the processed outlet is assuming a changing role in the industry.

The principles of crop distribution among the fresh and processed outlets have been discussed to indicate in specific terms the nature of some of the problems involved. Actual distributions were compared with estimated "optimum" distributions. The so-called optimum distributions are "optimum" only in the sense that they are consistent with realizing the maximum on-tree value of the total lemon crop in given seasons. Yet other considerations, especially problems of equity between production districts and among individual growers, merit attention, and they may well support valid departures from the "optimum" distribution. It is clear, however, that lemon growers as a group are likely to realize more from the whole crop when its distribution among the several alternative outlets is considered appropriately. Such distribution cannot be expected to solve all of the problems facing the lemon industry; new ones could arise. Yet, further progress can be made toward marketing the lemon crop most advantageously.

THE FOLLOWING TEN PAGES CONTAIN

APPENDIX TABLES

Table 1. Consumer Purchases and Retail Prices, Fresh Lemons and Canned Lemon Juice, by Months, October 1948 to July 1951

Year and month	Consumer purchases		Retail prices	
	Fresh lemons	Canned juice	Fresh lemons	Canned juice
	1,000 dozen	1,000 cases, 24 No. 2	cents per dozen	cents per No. 2 can
1948 October	6,236	35	45.2	28.0
November	6,903	31	43.9	28.8
December	6,224	34	44.7	28.1
1949 January	5,844	42	47.0	28.6
February	5,777	40	49.8	28.4
March	6,469	36	44.7	28.5
April	7,593	44	43.0	27.2
May	10,168	63	45.7	30.2
June	16,386	130	51.2	32.1
July	16,599	136	50.7	35.6
August	14,179	95	45.6	38.7
September	8,189	33	43.1	39.9
October	5,961	40	46.8	39.3
November	5,210	26	51.0	38.8
December	5,175	38	55.9	38.6
1950 January	5,164	37	61.3	38.1
February	6,119	40	48.1	38.3
March	7,258	37	44.4	40.3
April	7,465	37	40.8	40.2
May	9,594	48	42.4	41.7
June	15,557	96	45.5	41.0
July	15,355	112	44.4	41.4
August	13,930	67	40.3	42.1
September	7,705	43	41.8	41.1
October	7,088	34	40.5	37.7
November	6,043	31	40.8	38.8
December	6,126	35	42.8	38.9
1951 January	5,790	41	44.8	35.9
February	6,000	45	48.1	37.5
March	6,720	36	46.9	37.4
April	7,380	48	42.3	35.8
May	9,420	63	44.5	34.0
June	13,980	86	41.8	33.8
July	17,520	103	40.4	34.1

Source: National Consumers Panel of Industrial Surveys Company as reported in monthly issues of U. S. Bureau of Agricultural Economics, Consumer Purchases of Selected Fresh Fruits, Canned and Frozen Juices, and Dried Fruits, Washington, D.C.

Table 2. Summer Lemons: F.O.B. Prices and Major Factors Related to Them, 1922–1949. (Series Used for Determining Least Squares Multiple Regression Equation Given on Page 32)

Year, May–October	F.O.B. price	U.S. supply	Nonagricultural income	Mean monthly maximum temperature
	1	2	3	4
	dollars per box	100,000 boxes	1935–39 = 100	degrees F
1922	4.48	32.8	88	79.5
1923	5.23	31.2	100	79.0
1924	2.74	36.9	101	76.6
1925	4.93	39.9	110	79.9
1926	3.23	40.3	114	77.8
1927	4.88	35.1	116	76.6
1928	4.86	35.0	119	77.6
1929	5.36	35.5	125	78.7
1930	5.18	38.8	111	81.2
1931	4.50	39.9	95	80.7
1932	4.41	31.2	72	80.2
1933	3.60	35.4	70	81.1
1934	3.85	40.6	80	82.3
1935	3.39	41.6	86	78.7
1936	4.51	43.1	104	81.4
1937	4.86	38.7	109	80.1
1938	2.87	43.5	100	79.8
1939	3.17	47.0	107	80.9
1940	3.04	46.1	115	78.8
1941	3.19	55.0	141	81.0
war years				
1947	5.66	55.9[b]	282	79.6
1948	5.89	53.9[b]	306	80.2
1949	7.34[a]	50.8[b]	308	82.1

[a] Preliminary price of $7.32 was used in the calculation of the regression constants.
[b] Preliminary estimates of supply of 60.0 for 1947, 53.8 for 1948, and 49.9 for 1949 were used in the calculation of the regression constants.

Sources:
Col. 1: Based on prices received by the California Fruit Growers Exchange for lemons shipped during the specified periods and sold for consumption fresh. Beginning May, 1926, prices of lemons sold loose are included. For the seasons 1936–1941 prices of exported lemons are excluded.
Col. 2: 1922–1941 see Giannini Foundation Mimeographed Report No. 84, Table 18, p. 67. 1947–1949 based on total shipments for consumption fresh as reported by the Lemon Administrative Committee less domestic exports plus imports for consumption as reported in "Monthly Summary of Foreign Commerce of the United States" (U.S. Department of Commerce). Exports for 1949 and all imports converted from pounds to boxes on basis of 76 pounds per box.
Col. 3: 1922–1928 see Giannini Foundation Mimeographed Report No. 84, Table 22, p. 74. 1929–1949, averages of seasonally corrected monthly estimates of nonagricultural income as reported in "National Income Supplement to Survey of Current Business" (U.S. Department of Commerce).
Col. 4: Giannini Foundation Mimeographed Report No. 84, Table 35, p. 109 extended through 1949. The entries are monthly mean maximum temperatures May through September in 22 cities weighted by the average unloads of lemons for corresponding months.

Table 3. Winter Lemons: F.O.B. Prices and Major Factors Related to Them, 1922–1949. (Series Used for Determining Least Squares Multiple Regression Equation Given on Page 37)

Year, November–April	F.O.B. price	Domestic shipments	Nonagricultural income	Index of temperature
	1	2	3	4
	dollars per box	100,000 boxes	1935–39 = 100	1931–32 = 100
1921–22	3.48	16.4	81	81
1922–23	4.20	13.1	95	78
1923–24	2.38	19.1	105	85
1924–25	3.87	16.5	106	82
1925–26	3.33	17.5	115	80
1926–27	2.73	19.5	116	82
1927–28	4.81	15.2	116	84
1928–29	3.58	21.5	121	81
1929–30	4.94	15.6	119	86
1930–31	3.09	20.1	105	87
1931–32	2.49	19.8	83	100
1932–33	3.09	17.6	67	91
1933–34	3.20	20.7	77	76
1934–35	2.18	26.1	83	79
1935–36	3.72	23.4	92	67
1936–37	3.79	25.6	106	90
1937–38	3.50	22.8	100	84
1938–39	2.56	24.9	104	87
1939–40	2.99	27.5	111	77
1940–41	2.42	30.1	126	83
1941–42	3.21	27.8	156	82
war years				
1946–47	4.89	30.7	267	85
1947–48	4.78	30.1	294	75
1948–49	6.49[a]	28.6	309	92

[a] Preliminary price of $6.51 was used in the calculation of regression constants.

Sources:

Col. 1: Based on prices received by the California Fruit Growers Exchange for lemons shipped during the specified periods and sold for consumption fresh. Beginning with November, 1926, prices of lemons sold loose are included. For the seasons 1935–1941, prices of exported lemons are excluded.

Col. 2: For seasons through 1940–41 see Giannini Foundation Mimeographed Report No. 84, Table 17, p. 65. Data for later seasons are based on total shipments for consumption fresh as reported by the Lemon Administrative Committee less domestic exports as reported in "Monthly Summary of Foreign Commerce of the United States" (U.S. Department of Commerce). Exports for 1949 and all imports converted from pounds to boxes on a basis of 76 pounds per box.

Col. 3: Figures are averages of seasonally corrected monthly estimates. Through the season 1928–29 averages are based on monthly relatives reported in "Nonagricultural Income Payments, United States, 1919 to Date," Bureau of Agricultural Economics, Washington, D.C., July 21, 1941 (Mimeo.). For later seasons, the sources are July 1947 Supplement to "Survey of Current Business" (U.S. Department of Commerce) and current issues of the Survey.

Col. 4: Giannini Foundation Mimeographed Report No. 84, Table 23, p. 77 extended through 1949. The entries are based on monthly mean temperatures, December through February in 32 cities weighted by the population in the corresponding metropolitan districts.

Table 4. Fresh Winter Lemons; Derived "Optimum" Shipments[a] (Unconstrained), and Actual Shipments from 1921–22

Season	a_w	Computed "optimum" shipments	Actual shipments
	1	2	3
		100,000 boxes	
1921–22	7.411484	13.8	16.4
1922–23	7.828091	14.6	13.1
1923–24	7.865984	14.7	19.1
1924–25	8.095248	15.1	16.5
1925–26	8.407693	15.7	17.5
1926–27	8.476422	15.8	19.5
1927–28	8.530740	15.9	15.2
1928–29	8.817648	16.5	21.5
1929–30	8.746823	16.3	15.6
1930–31	8.631494	16.1	20.1
1931–32	8.015593	15.0	19.8
1932–33	8.192512	15.3	17.6
1933–34	8.936759	16.7	20.7
1934–35	9.045436	16.9	26.1
1935–36	9.678951	18.1	23.4
1936–37	.....[b]	.....[b]	.....[b]
1937–38	9.485484	17.7	22.8
1938–39	9.565339	17.8	24.9
1939–40	10.105818	18.8	27.5
1940–41	10.247873	19.1	30.1
1941–42	10.830842	20.2	27.8
war years			
1946–47	12.926802	24.1	30.7
1947–48	13.755501	25.7	30.1
1948–49	13.544379	25.3	28.6

[a] Using equation 1W in Table 8, page 76, the annual values of the independent variables (except shipments) were used to obtain, for each year, a winter seasonal statistical demand equation in the form $p_w = a_w - 0.267921\ q_w$. The a_w values, for the individual years, are in Col. 1, above. The computed "optimum" shipments were derived from the condition that $q_w = (a_w)/2(0.267921)$.

[b] The 1936-37 winter season was omitted from the analysis because of the unusual price-quantity relation of that year, due to nonmaterialized expectations of frost damage to the crop.

Table 5. Fresh Summer Lemons; Derived "Optimum" Shipments[a] (Unconstrained), and Actual Shipments from 1921–22

Season	a_s	Computed "optimum" shipments	Actual shipments
	1	2	3
		100,000 boxes	
1921–22	8.000752	34.8	32.8
1922–23	8.347082	36.4	31.2
1923–24	7.731569	33.7	36.9
1924–25	9.126139	39.8	39.9
1925–26	8.666434	37.8	40.3
1926–27	8.404379	36.6	35.1
1927–28	8.840257	38.5	35.0
1928–29	9.386952	40.9	35.5
1929–30	9.705312	42.3	38.8
1930–31	9.011042	39.2	39.9
1931–32	8.073696	35.2	31.2
1932–33	8.231741	35.8	35.4
1933–34	8.853242	38.6	40.6
1934–35	7.838952	34.1	41.6
1935–36	9.150085	39.8	43.1
1936–37	8.783115	38.2	38.7
1937–38	8.257394	36.0	43.5
1938–39	8.665635	37.4	47.0
1939–40	8.096038	35.3	46.1
1940–41	9.424926	41.0	55.0
war years			
1946–47	12.024619	52.4	55.9[b]
1947–48	12.672892	55.2	53.9[b]
1948–49	12.997225	56.6	50.8[b]

[a] Using equation 1S in Table 8, page 76, the annual values of the independent variables (except U.S. supply) were used to obtain, for each year, a summer seasonal statistical demand equation in the form $p_s = a_s - 0.114787\ q_s$. The a_s values, for the individual years, are in Col. 1, above. The computed "optimum" shipments were derived from the condition that $q_s = a_s/2(0.114787)$.

[b] Preliminary estimates of shipments of 60.0 for 1947, 53.8 for 1948, and 49.9 for 1949 were used in calculation of regression constants.

Table 6. California Lemons, "Optimum"[a] (Constrained) Allocation Between Summer and Winter Fresh Shipments from 1921–22

Season	a_w	a_s	Constrained "optimum" winter shipments[b]	Constrained "optimum" summer shipments[c]
			100,000 boxes	
1921–22	7.411484	8.000752	13.986869	35.213131
1922–23	7.828091	8.347082	12.609009	31.690991
1923–24	7.865984	7.731569	16.971894	39.028106
1924–25	8.095248	9.126139	15.569420	40.830580
1925–26	8.407693	8.666434	16.998124	40.801876
1926–27	8.476422	8.404379	16.470498	38.129502
1927–28	8.530740	8.840257	14.652291	35.547709
1928–29	8.817648	9.386952	16.352433	40.647567
1929–30	8.746823	9.705312	15.064144	39.335856
1930–31	8.631494	9.011042	17.500146	42.499854
1931–32	8.015593	8.073696	15.220705	35.779295
1932–33	8.192512	8.231741	15.845231	37.154769
1933–34	8.936759	8.853242	18.495045	42.804955
1934–35	9.045436	7.838952	21.881753	45.818247
1935–36	9.678951	9.150085	20.636539	45.863461
1936–37*				
1937–38	9.485484	8.257394	21.490073	44.809927
1938–39	9.565339	8.665635	22.740673	49.159327
1939–40	10.105818	8.096038	24.700850	48.899150
1940–41	10.247873	9.424926	26.599515	58.500485
war years				
1946–47	12.926802	12.024619	27.152935	59.447065
1947–48	13.755501	12.672892	26.608831	57.391169
1948–49	13.544379	12.997225	24.529576	54.870424

[a] Using the seasonal price-quantity net relations, $p_w = a_w - 0.267921q_w$ and $p_s = a_s - 0.114787q_s$, where $q_w + q_s = Q$.

[b] $q_w = \dfrac{a_w - a_s + 2(0.114787)Q}{2(0.267921 + 0.114787)}$.

[c] $q_s = Q - q_w$.

* The 1936–37 marketing year was omitted from the analysis.

Note: The equations $p_w = a_w - 0.267921q_w$ and $p_s = a_s - 0.114787q_s$ respectively, are based on equations 1S and 1W in Table 8, page 76, also from which the a_w and a_s for the individual years were obtained by substituting the annual values for all the independent variables except q.

Table 7. California Lemons, "On-Tree" Prices, Quantities Utilized, Fresh and Processed Use, and U. S. Nonagricultural Income, from 1921–22

Season	"On Tree" prices		Quantities utilized		U.S. nonagricultural income
	Fresh use	Processed use	Fresh use	Processed use	
	1	2	3	4	5
	dollars per packed box equivalent		1,000 packed boxes		1935–39 = 100
1921–22	2.34	0.01	4,085	281	84.5
1922–23	3.06	0.01	3,676	96	97.5
1923–24	0.97	0.15	5,264	1,157	103.0
1924–25	2.87	0.15	4,775	515	108.0
1925–26	1.75	0.20	5,821	1,484	114.5
1926–27	2.53	0.22	4,534	2,315	116.0
1927–28	3.27	0.55	4,895	511	117.5
1928–29	3.15	0.40	5,574	2,033	123.0
1929–30	3.49	0.16	5,629	466	115.0
1930–31	2.53	0.06	5,704	2,232	100.0
1931–32	2.18	0.02	5,247	2,435	77.5
1932–33	2.13	0.01	5,742	948	68.5
1933–34	2.48	0.08	6,194	1,087	78.5
1934–35	1.71	0.07	7,184	3,549	84.5
1935–36	2.93	0.48	7,422	351	98.0
1936–37	3.04	0.54	6,533	1,032	107.5
1937–38	1.70	0.11	7,761	1,529	100.0
1938–39	1.56	0.05	7,777	3,315	105.5
1939–40	1.67	0.22	8,327	3,642	113.0
war years					
1946–47	3.07	−0.28	9,369	4,414	274.5
1947–48[a]	3.02	−0.36	8,469	4,386	300.0
1948–49[a]	4.45	0.05	7,780	2,215	308.5
1949–50	3.89	0.33	7,569	2,916	323.9

[a] The following preliminary on tree prices were used in the regression analyses: 1947–48, fresh use 3.00, processed use −0.47; 1948–49, fresh use 4.57, processed use −0.34.

Sources:

Cols. 1 and 2: U. S. Bureau of Agricultural Economics. "Fruit and Nut Prices, Prices Received by Growers for Fruit and Nut Crops, by Type of Sale and Utilization Groups, 1909–1946," and "Agricultural Prices," Oct. 27, 1950.

Cols. 3 and 4: U. S. Bureau of Agricultural Economics. "Citrus Fruits, Production, Farm Disposition, Value and Utilization of Sales," Oct. 1945, Oct. 1947, Oct. 1948, Oct. 1949, and Oct. 1950.

Col. 5: Computed from data published monthly in "Survey of Current Business," Bureau of Foreign and Domestic Commerce, U. S. Dept. of Commerce.

Table 8. Fresh Lemon Prices and Major Factors Related to Them, Multiple Regression Equations and Auxiliary Constants, Summer and Winter, 1921–22 to 1948–49 (Excluding the War Years)

Equation No.	Dependent variable	Constant term	Independent variables							Adjusted coefficient of multiple correlation $\bar{R}$
			X_2	X_3	X_4	T	T^2	Y_p	X_p	
			Figures in parentheses are t-ratios							
			Summer Lemons[a]							
1S	X_1	−19.360458	−0.114787 (4.337848)	0.032286 (6.667878)	0.310328 (3.934543)	−0.099363 (2.510409)	−0.008537 (2.418612)			.911
2S	X_1	−22.200704	−0.115289 (4.627824)	0.030457 (6.519027)	0.345077 (4.495489)	−0.075456 (1.905655)	−0.004673 (1.178134)	1.113507 (1.784184)		.922
3S	X_1	−18.365946	−0.109731 (3.694197)	0.031866 (6.292359)	0.296874 (3.411109)	−0.094336 (2.228998)	−0.008458 (2.334246)		−0.000036 (0.417995)	.906
			Winter Lemons[b]							
1W	X_1	10.385776	−0.267921 (6.319488)	0.014411 (7.424398)	−0.032107 (2.216604)	0.118532 (3.814464)				.915
2W	X_1	9.613478	−0.300326 (9.679325)	0.017274 (11.295347)	−0.020192 (1.896050)	0.153375 (6.528290)		1.836817 (4.323141)		.958
3W	X_1	8.713551	−0.207401 (3.188888)	0.014059 (7.255551)	−0.024318 (1.552167)	0.102721 (3.083317)			−0.000124 (1.215491)	.917

[a] Summer Lemons
X_1 = F.o.b. price of summer lemons (dollars per box).
X_2 = U. S. supply of summer lemons (100,000 boxes).
X_3 = U. S. nonagricultural income (1935–39 = 100).
X_4 = Mean monthly maximum temperature (May–September).
T = Time, origin at 1935.
Y_p = On-tree price of processed lemons.
X_p = Quantity of lemons processed.

[b] Winter Lemons
X_1 = F.o.b. price of winter lemons (dollars per box).
X_2 = Domestic shipments of winter lemons (100,000 boxes).
X_3 = U. S. nonagriculrual income (1935–39 = 100).
X_4 = Index of mean monthly temperature (December through February).
T = Time, origin at 1934–35.
Y_p = On-tree price of processed lemons.
X_p = Quantity of lemons processed.

The series of data from which the regression coefficients were calculated are as follows: for X_1, X_2, X_3, X_4; Summer, Table 2; Winter, Table 3; for Y_p and X_p, Table 7.

Table 9. California Lemons, Fresh and Processed; "On Tree" Returns and Major Factors Related to Them, from 1921–22 through 1949–50, Excluding 1936–37 and 1940–41 through 1945–46. Multiple Regression Equations and Auxiliary Constants

Equation No.	Dependent variable	Constant term	Independent variables[a]								Adjusted coefficient of multiple correlation $\bar{R}$
			Y_f	Y_p	X_f	X_p	I	S	W	T	
			Figures in parentheses are t-ratios								
1	Y_f	—5.627132			—0.000465 (2.123917)	—0.000166 (1.168916)	0.008196 (2.952646)	0.150844 (1.537160)	—0.018588 (1.021058)	0.060640 (1.096663)	.8245
2	Y_p	10.986118			—0.000043 (0.504559)	—0.000146 (2.652561)	—0.002627 (2.446055)	—0.120083 (3.162990)	—0.003993 (0.566979)	0.039798 (1.860367)	.6386
3	Y_p	10.482012			—0.000017 (0.246382)	—0.000153 (2.921348)	—0.002519 (2.435606)	—0.120121 (3.233287)		0.035257 (1.816300)	.6580
4	Y_p	10.214342				—0.000155 (3.110915)	—0.002394 (2.735257)	—0.118368 (3.339723)		0.031661 (2.545236)	.6814
5	X_f	8,510.7448	—596.777130 (2.161763)	269.870621 (0.385104)			0.499136 (0.103634)	38.735676 (0.288920)	—41.500017 (2.577836)	185.254688 (5.587394)	.9480
6	X_f	11,643.2015	—535.620385 (3.113203)	139.004670 (0.267731)			—0.621080 (0.223750)		—41.789723 (2.678740)	192.637393 (9.391517)	.9511
7	X_f	11,712.1684	—523.770840 (3.240053)				—0.860948 (0.336987)		—42.433038 (2.831202)	192.347687 (9.657863)	.9538
8	X_f	11,688.9645	—556.077080 (4.381516)						—42.696325 (2.925604)	187.216582 (14.955570)	.9561
9	X_p	45,660.0376	—30.270531 (0.074800)	—2,274.391 (2.213121)			—8.553533 (1.210721)	—528.716013 (2.689061)	2.555870 (0.108305)	187.034938 (3.846775)	.8417
10	X_p	45,975.9690	—26.427511 (0.067646)	—2,291.921 (2.331540)			—8.592306 (1.257222)	—530.041828 (2.788551)		187.336586 (3.984335)	.8523
11	X_p	46,754.7002		—2,333.015 (3.110902)			—8.987830 (2.616396)	—539.889765 (4.551860)		189.528189 (5.731697)	.8616
12	X_p	34,242.2998		—1,663.159 (2.049951)				—400.848459 (3.284388)		120.975676 (5.210545)	.8117

[a] Y_f = On-tree returns from fresh utilization (in dollars per box), in Col. 1, Table 7.
Y_p = On-tree returns from processed utilization (in dollars per box), in Col. 2, Table 7.
X_f = Quantity of lemons used fresh (in 1,000 packed boxes), in Col. 3, Table 7.
X_p = Quantity of lemons processed (in 1,000 packed boxes), in Col. 4, Table 7.
I = U. S. nonagricultural income (1935–39 = 100), in Col. 5, Table 7.
S = Summer temperature, mean monthly maximum (in degrees F), in Col. 4, Table 2.
W = Winter temperature index (1931–32 = 100), in Col. 4, Table 3, extended through 1949–50.
T = Time, origin at 1935–36.

Table 10. California Lemons, "Optimum" (Constrained) Allocation[a] Between Fresh and Processed Utilization from 1921–22

Season	a_f	a_p	Constrained "optimum" fresh allocation[b]	Constrained "optimum" process allocation[c]
			1,000 equivalent packed boxes	
1921–22	5609.5	420.295	3064.775	1301.225
1922–23	5924.8	762.875	3044.802	727.198
1923–24	5813.1	2198.690	3371.347	3049.653
1924–25	6128.4	561.570	3438.526	1851.474
1925–26	6401.0	1826.425	3814.676	3490.324
1926–27	6502.8	2650.320	3688.740	3160.260
1927–28	6604.6	2286.435	3487.149	1918.851
1928–29	6919.9	1832.600	4081.721	3525.279
1929–30	6893.6	744.270	3884.838	2210.162
1930–31	7038.1	1338.570	4240.304	3695.696
1931–32	6670.2	2000.295	3979.196	3702.804
1932–33	7241.7	1784.795	4039.775	2650.225
1933–34	8069.4	1236.515	4540.478	2740.522
1934–35	8128.5	3315.715	5028.617	5704.383
1935–36	8828.1	1926.120	4875.149	2897.851
1936–37	8033.2	2732.085	4436.604	3128.396
1937–38	8476.6	3150.980	4907.311	4382.689
1938–39	8535.7	2697.145	5321.648	5770.352
1939–40	9149.9	3953.010	5617.579	6351.421
war years				
1946–47	10118.7	3395.705	6411.494	7371.506
1947–48	10732.9	3032.020	6515.890	6339.110
1948–49	10194.2	2119.295	5835.788	4159.212
1949–50	10424.1	3736.059	5867.341	4617.659

[a] Using the seasonal price-quantity net relations, $q_f = a_f - 2{,}333.015p_f$ and $q_p = a_p - 556.0771p_p$, where $q_f + q_p = Q$.

[b] $$q_f = \frac{2{,}333.015a_f - 556.0771a_p + 2(556.0771Q)}{2(2{,}333.015 + 556.0771)}.$$

[c] $q_p = Q - q_f$.

Note: The equations $q_f = a_f - 2{,}333.015p_f$ and $q_p = a_p - 556.0771p_p$, respectively, are based on equations 8 and 11, Table 9, page 77, also from which a_f and a_p for the individual years were obtained by substituting the annual values for all the independent variables except p.

The tables and figures appearing in this circular are summaries of more detailed tables, which are published in a separate Statistical Supplement in mimeographed form and which give the sources in detail. This supplement can be obtained by writing to the Giannini Foundation of Agricultural Economics, University of California, Berkeley 4, California.

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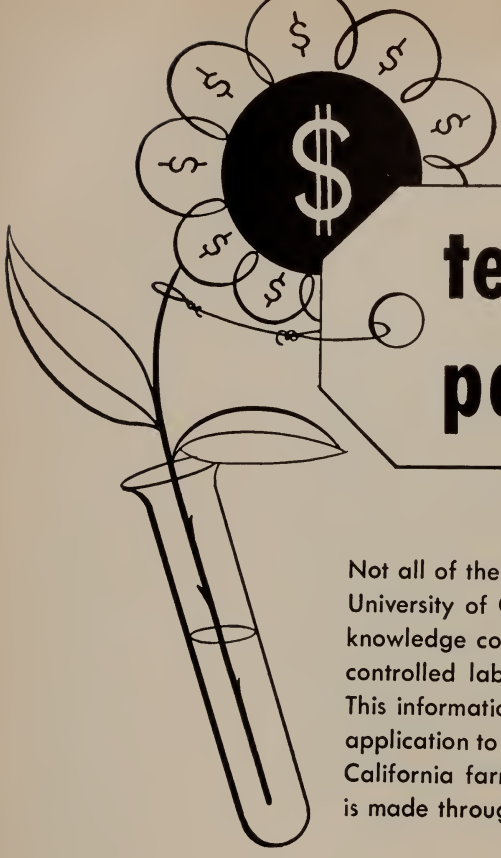

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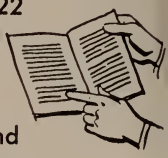

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